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June, 1959

INDUSTRIAL QUALITY CONTROL

In This Issue

Airframe Industry SQC

Quality Status Program

Design of Experiments

Random Balance

QUALITY through Scientific Methods

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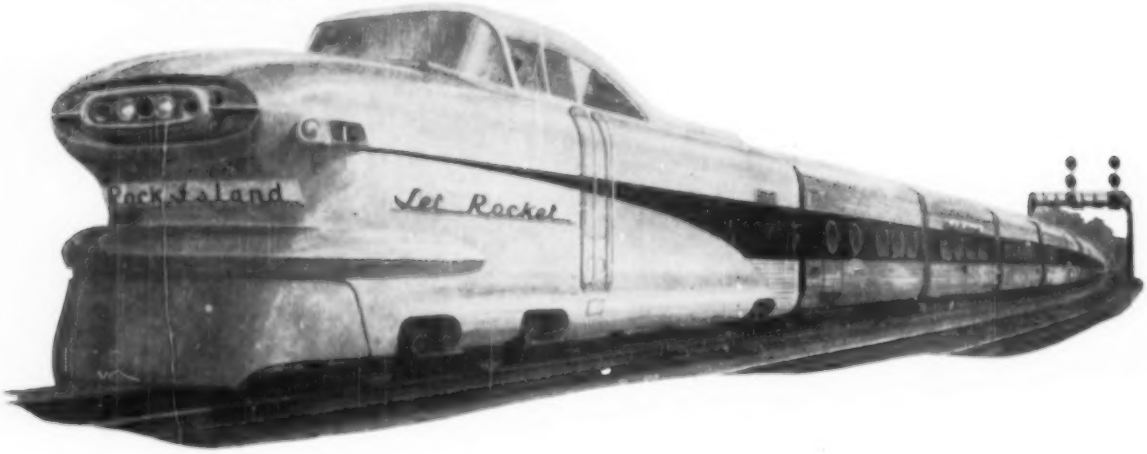

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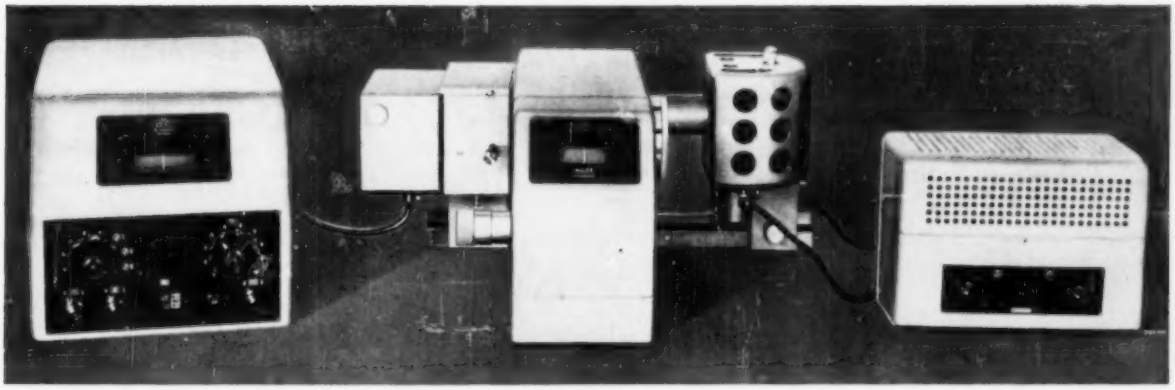

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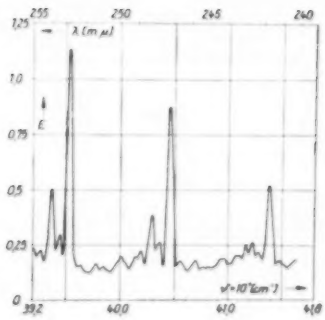

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Practical

Statistical Quality Control

in the Airframe Industry

Part III

J. Y. McCLURE

Convair, A Division of General Dynamics Corporation, Fort Worth, Texas

Editorial Note

This concludes Mr. McClure's article which began in the April issue of *Industrial Quality Control*. Part II appeared in the May issue.

Simple SQC in Assembly Departments

The control of incoming parts and materials, reliable tools and fabricated parts minimize the troubles inherent in sub- and final assembly of the airframe.

Assembly build-up operations are accomplished and inspected on a sequenced basis. The inspection data necessary for statistical quality control audits can be collected at each inspection check point.

The data most commonly collected are

1. Defects per established unit
2. Percent defective
3. Avoidable loss generated per established unit

Units of measurement are usually established at natural breaking points between department, cost center, work station, aircraft component/system, ass't. foreman responsible, etc. This permits the isolation of trouble spots for further applications of SQC techniques and supervisory emphasis.

The results of these "work performance" audits should be published and posted on area chart boards. This permits the workers to view their performance.

Troubles encountered in assembly departments, which can be traced back to defective detail parts, can be handled at the source of error by statistical techniques as explained or referenced in the sections headed "SQC in Tool Manufacturing" and "Fabrication Quality Control."

A typical problem encountered in assembly departments is the assembly "spring-back" problem which is the result of stresses built up during the assembly process. Statistical studies can often point the way to a solution. These departures from specifications, requiring rework, can be eliminated by proper emphasis on the quality of jigs and fixtures.

In analyzing assembly problems it must be remembered that "accumulation of tolerance" and "interchangeability" problems begin to show up in the assembly departments. Problems often must be traced all the way back to fabrication and receiving.

The type of control commonly used in assembly operations are the p and c charts. These techniques are discussed and referenced elsewhere in this article.

Many areas exist which are suitable for applications of sampling techniques; especially in the major assembly departments. Examples are rivet holes, rivet installation, attachment holes, etc.

Pre-Flight and Final Acceptance Quality Control Techniques

Final steps are necessary to assure that the aircraft has been properly prepared for ground and flight tests and that all items which would affect safety of operation or flight have been corrected.

Quality can be measured by various units such as systems, geographic areas, components, work teams, etc. This breakdown of systems and units automatically establishes the scope of individual quality measurements.

The c chart (defects per unit) is well suited for measuring quality at this phase of manufacture. Each of the above systems or area breakdowns can be compared with successive ships, systems, areas, etc.

These charts can also be used to build up historical quality records of normal performance by the various breakdowns. Control limits, having been established on each of the breakdowns charted, facilitate the detection of abnormal conditions, trends, runs, etc., and the correction and/or prevention of recurrence.

Quality control charts maintained in the work areas inform the employees of the quality of their work performance. This creates a spirit of competition, which is in itself, a healthy condition.

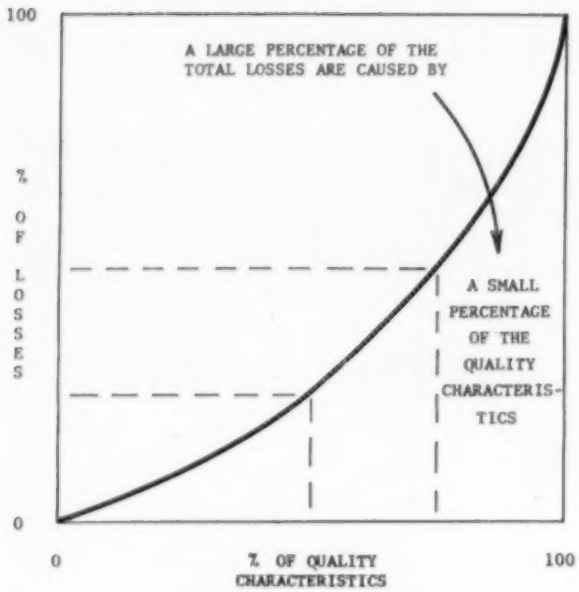

Figure 8—Maldistribution Principle

Tabular and graphic reports of the process should be published periodically to aid production and inspection supervision in pinpointing their quality problems.

High Spot Reports (see Fig. 12) are a valuable aid. These reports, issued by SQC, give production supervision the pertinent facts relative to a specific trouble spot. They also point out any condition that has become repetitive in nature.

One example of an economical method for the acceptance of areas after final clean-up is outlined below.

Acceptance Inspection by Area Sampling

1. For this example, let's use an inspection level of 20 percent coverage.

Note: The aircraft will be inspected for critical characteristics regardless of the area selected by the sampling plan.

2. The acceptance inspection of the aircraft is conducted in geographical areas. In this case 40 areas are used.
3. The area sampling device is the Ball and Paddle Method. In order that all 40 areas be under chance consideration, the paddle has 40 holes which are numbered one though 40. The paddle is dipped into a box containing 400 balls, of which 20 percent are red and 80 percent are white. The red balls that fall into the numbered paddle holes denote the areas to be inspected on this particular aircraft.
4. The indicated areas are inspected 100 percent and the results recorded. The average defects per area per aircraft are plotted and the process average is determined.
5. The upper and lower control limits are computed.
6. The inspection level is adjusted on a five-ship frequency basis as necessary. The basic unit of comparison is the average number of defects per area per ship. Changes from the 20 percent level shall be based on sampling data, using the following method:
   a. If the averages of the defects per area exceed the previously established U.C.L., inspection is tightened by removing five white balls and adding five red balls. This tightens the area to 21¼ percent as shown in Table III.
   b. If the averages of the defects per area are below the L.C.L., the level of inspection is reduced by adding five white balls and removing five red balls (18¾ percent).
   c. If the process remains within control limits, the level of inspection is not changed.
   d. The increments of change in the level of inspection are based on keeping the total number of balls at 400, and the sample selected at 40.

Defects per unit (c chart) can be utilized effectively in analyzing areas selected by this sampling plan.

Flight Test Data

The final quality evaluation of the entire aircraft, its structure, systems, components, accessories, etc., is made during the flight test. Here, the aircraft is brought into contact with actual physical and environmental conditions which have only been simulated before. The manner in which the completed product meets these tests is proof of the quality of materials and workmanship built into the aircraft.

A list of check points is used effectively for setting up c and p charts to establish the process average and measure the quality of individual ships, components, and systems.

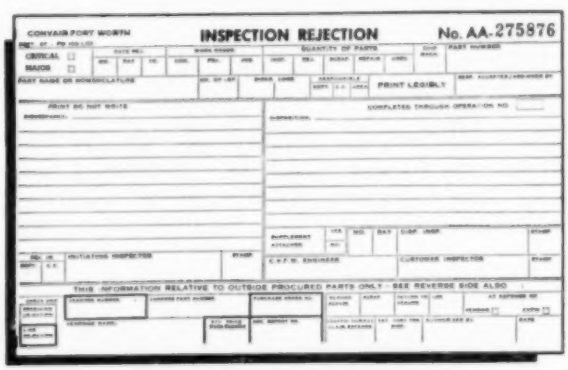
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Figure 9—Inspection Rejection Form

A demerit rating is useful in weighting the more important defects and their effect on the performance or useability of the end product.

These charts, when applied to homogeneous sets of data, reveal the presence of assignable causes.

Quality Audits for Management and Supervisory Control

This section is presented not only to discuss information on "quality auditing" but also to summarize, by means of further emphasis, some of the more important methods and mechanics already discussed in this article for Practical Statistical Quality Control in the Airframe Industry. These more important items include:

1. Control of rework and scrap losses
2. Isolation of costly and troublesome areas for remedial action
3. Utilization of mechanical means for processing of quality data

TABLE III—Inspection Level Chart

Total	Number of Balls		Inspection Level (Percent)
	Red	White	
400	100	300	25.00
400	95	305	23.75
400	90	310	22.50
400	85	315	21.25
400	80	320	20.00
400	75	325	18.75
400	70	330	17.50
400	65	335	16.25
400	60	340	15.00

4. Publication of the quality facts for cognizant personnel and management

Measuring performance, a quality audit, is an integral function of statistical quality control. Three units of measurement have been used predominantly throughout industry:[1] (1) percent defective, (2) defects per unit, and (3) frequency of errors. These measurements have been used very successfully in securing quality improvements; and yet in many cases, have been insufficient to evaluate economics, another important aspect of quality control. In order to evaluate performance from an economic standpoint, another type of measurement, "avoidable costs," is being used in quality auditing. The use of "avoidable costs per 100 labor hours" as a unit of measurement accomplishes a practical purpose by measuring performance in relation to task accomplished, and at the same time performing a partial "gold-in-the-mine-study." This "study" defines performance in terms of economic impact, and facilitates the discernment and judgment of trouble areas, in terms of dollars and cents.

Three tangible costs, generated by manufacturing, can be measured and combined to describe departmental performance:

1. Direct labor hours expended in rework
2. Standard hours scrapped
3. Scrapped material cost

Scrap and rework are generated throughout an entire airframe plant; however, certain factors inherent in departmental processes cause a maldistribution of losses attributed to scrap and rework. These losses are always maldistributed in such a way that a small percentage of the characteristics being measured contribute to a high percentage of the avoidable costs.[2]

This maldistribution can be used to an advantage, in that it pinpoints areas where the maximum savings can be gained with a relative minimum of effort. By measuring the economic impact of rework and scrap, one is able to isolate the small percentage of the quality characteristics causing a large percentage of the total losses. This isolation, or pinpointing of the trouble areas, facilitates action necessary to correct and/or prevent recurrence. (See Fig. 8.)

Rework and scrap information can be collected on an inspection rejection data form (see Fig. 9) designed for this purpose. A practical approach to collecting the desired rework information is to have the reworking shop personnel record the time expended in performing the operations specified in the materials review disposition. The reverse side of the rejection form should be patterned to accommodate several rework time entries for cases where multiple rework operations are necessary. The rework time is then totaled and recorded on the face of the rejection form.

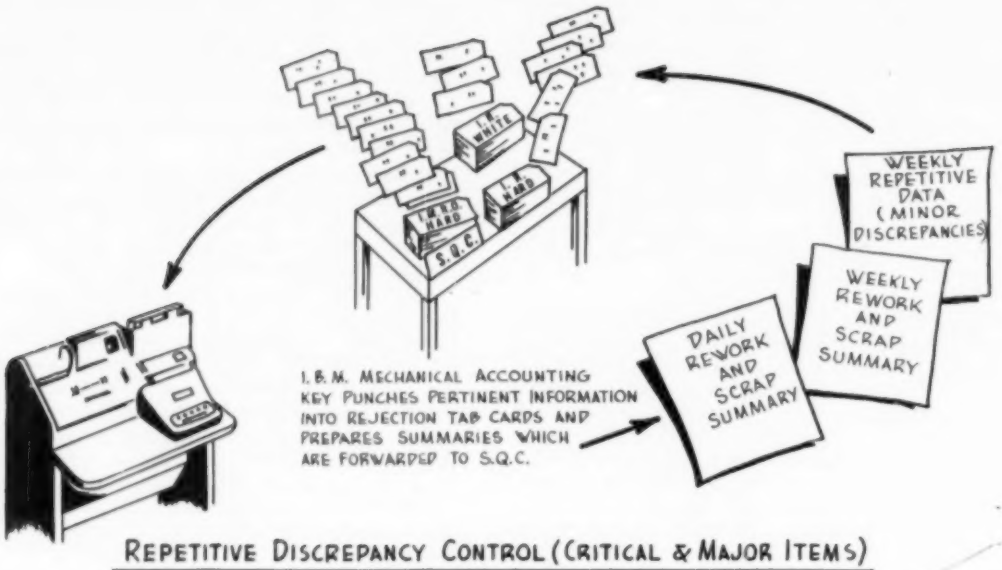
The collection of scrap-loss data is more complicated, for two items must be considered. They are scrapped labor and scrapped material. A scrap-cost pricing operation must be administered to determine these losses. The procedure may be handled in the following manner. (See Fig. 10.)

1. In the event it is decided that parts should be scrapped, the dispositioning materials review inspector records the last labor operation performed on the parts prior to scrapping.
2. SQC, upon receipt of the rejection, obtains the applicable planning paper and computes the labor loss for all operations completed on the parts. The material value is also determined by SQC with the aid of a "material cost catalog."

IBM mechanical equipment, if available, is usually beneficial in processing data for timely performance reports.[3] Where large quantities of quality data must be compiled to derive performance audits, a mechanical set-up will eliminate routine work by the SQC group and give them more time for analysis and trouble-shooting activities. Key-punched data cards obtained from IBM machines are invaluable because of their versatility. Information reports may be mechanically tabulated for any desired arrangement of the data. For example, certain airframe manufacturers who are required to maintain control of repetitive type discrepancies[4] accomplish classification of repetitive dis-

Figure 10—Scrap Cost Pricing

GENERAL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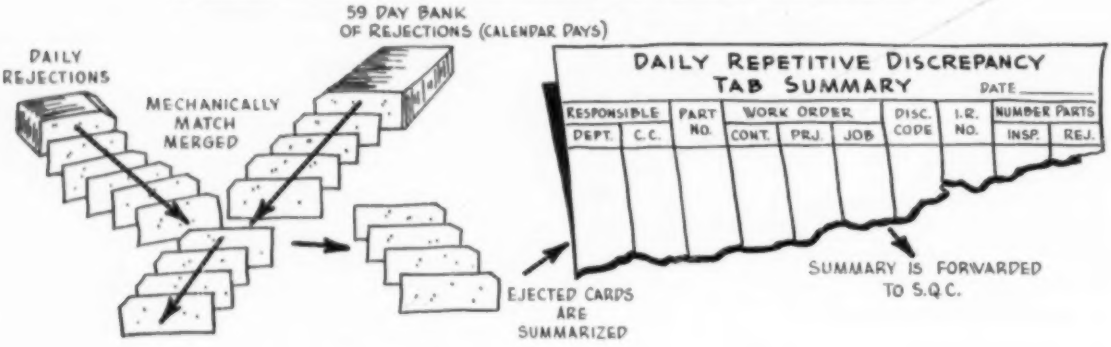

Figure 11—Use of IBM Equipment to Control Repetitive Discrepancies

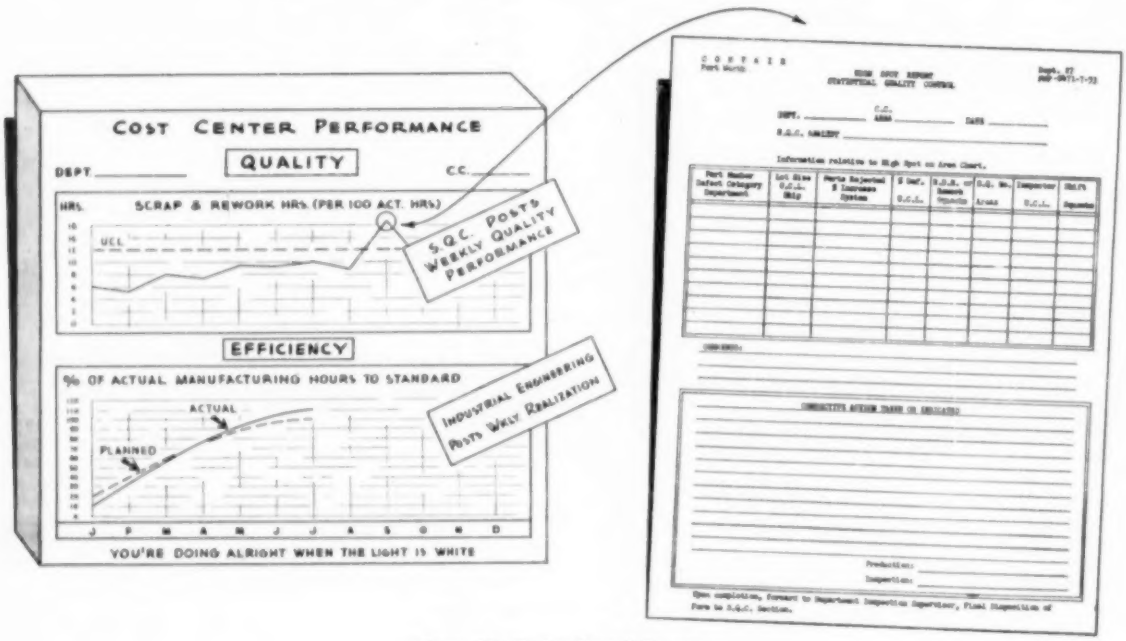

Figure 12—Quality Control Reports

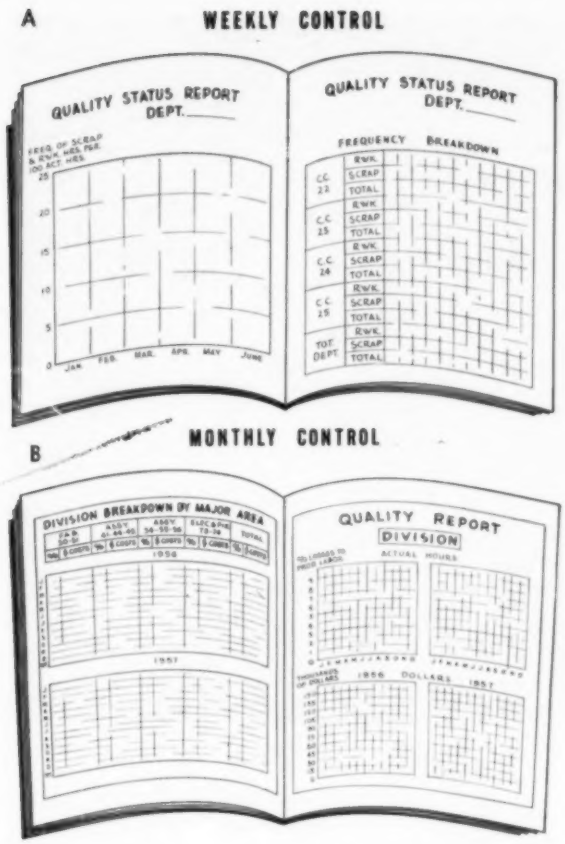

Figure 13—Report Samples for Supervision and Management

crepancies through IBM machines used in conjunction with other quality tabulation functions. (See Fig. 11.)

Regardless of the type of quality measurement applied and the analysis performed, data retained in the SQC engineer's desk is of little value unless reports are issued to relate the facts to responsible people. As the Scottish essayist and historian, Thomas Carlyle, has said, "The purpose of education is not knowledge, but action." After collecting data and measuring the quality performance, it's time to take action.

Reports should be tailored to fit a company's need; at least three levels of reporting are recommended for maximum quality action:

1. Workers and first line supervision (Fig. 12)
2. General foremen (Fig. 13A)
3. Management (Fig. 13B)

The first level of reporting may be accomplished through use of quality charts in the applicable work areas. The maintenance of these charts on a daily or weekly basis keeps workers and supervisors informed of their current quality level. Out-of-control points or other evidence of assignable causes may be identified and reported on "High Spot Reports" to the responsible area supervisor for corrective action.

The general foreman or supervisor, in turn, should be informed of quality conditions in all the areas of his jurisdiction, as well as the overall quality level of the department. This may be done through utilization of a weekly quality status report.

Finally, a report of the quality-facts should be made to the company's management. Here again, reports should be patterned to fit the individual company's needs and desires. A monthly report to management is generally used. The report to this organizational level should contain sufficient data to depict quality performance by each major area and of the plant overall. A graphic presentation of the progressive data will enable management more clearly to recognize trends and initiate proper action.

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(1) American War Standards: "Guide for Quality Control," Z1.1-1941; "Control Chart Method of Analyzing Data," Z1.2-1941; and "Control Chart Method of Controlling Quality During Production," Z1.3-1942; American Standards Association, Inc., New York
ASTM Manuals on "Quality Control of Materials," American Society for Testing Materials, Philadelphia, 1951

(2) Juran, J. M., *Quality Control Handbook*, McGraw-Hill Book Co., Inc., New York, 1951 (Pareto's theory of unequal distribution)

(3) IBM Manuals: #32-8683-1, #29-0945-0

(4) Military Specification: MIL-Q-5923B

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Quality Control Laboratory

How is Quality Today?

R. G. CORDES

*Star Cooler Corporation**
St. Louis, Mo.

Figure 1—The line inspector is shown here as she makes one of her hourly reports to the quality control technician.

If you are a quality control supervisor or foreman, then you undoubtedly are often confronted with the question, "How is quality today?". Sometimes that question is difficult to answer because your communications with the inspectors on the line are such that it requires hours, or perhaps even days, to learn of a problem.

In order to improve communications, a system has been devised at The O. A. Sutton Corporation which shows an up-to-the-minute status of quality throughout the plant. This company builds window air conditioners, automobile air conditioners, circulating fans, motors, and defense items. The manufacturing facilities cover 200,000 square feet.

One of the first steps in the program was to write a "Test and Inspection Manual" covering all procedures used throughout the quality control organization. The manual is available to each inspector as a guide to his specific operation as well as an instruction manual to improve the inspector's concept of the entire quality control function. Every inspector in the plant keeps a record of the defects found at his particular station. (See Fig. 1.) Information is relayed to a central source once every hour and sorted into classifications. A daily record is kept of the number of defects by classification, by product.

At the beginning of the program, a process average was computed for each defect and control limits were set, based on the lot size and the process average. The day-to-day results were compared to the control limits, and the out-of-control conditions were brought to the attention of the personnel who could best effect action. As might be expected, the recording of every defect and the calculation of process averages and control limits was time-consuming; the system has since been simplified so that the control limits are kept on a group of defects rather than each one individually. As an example, the air conditioner line defects are divided into four general classifications:

1. **Field Failure Problems**
   The field failure category includes any defects which would cause a field failure if they had not been detected on the line.
2. **Service Call Problems**
   The service call defects are those that would result in a service call to the customer's home if they had gone undetected.
3. **Customer Irritation**
   The customer irritation defect is that class which would be bothersome to the average customer, but not to the extent that he would call a service man for a correction.
4. **Factory Correction**
   The factory correction defect would not be noticed by the average customer, but would result in a better product.

A control limit is set for each of the four categories, based on the process average, using a factor of judgment to keep the control limits at a level recognized as "commercial field quality." It is known from a number of years of field experience that a direct ratio exists between the number of defects found in the plant and the number of like defects found in the field. By using this ratio and establishing an acceptable field quality level, the acceptable line quality level can be determined.

All the field failure records in the form of service station repair reports and service call reports are sent to the Quality Control Department for analysis and summary. By assuming this function, it is possible to keep

*At the time this article was prepared, Mr. Cordes was with The O. A. Sutton Corp., Inc., Wichita, Kans.

abreast of the exact nature of the quality problem in the field and to correlate the field problem with the factory problem. Having established the control limit on each classification of defect, it is then possible to summarize the hour-by-hour number of defects so that each area can be rated as either being "in or out" of control.

The next stop in the communication chain is to inform production supervision of the out-of-control condition so that action can be assured. To accomplish this, a set of control lights has been installed in the quality control office. (See Fig. 2.) The control board has ten categories covering the ten major subsections of the plant production. Each category has a red light which can be either on or off, depending on whether or not that area is in control. When the light is on, this means that the area is outside of the control limits established as acceptable for good quality. If the question should arise "How is Quality?" a quick glance at the board immediately tells what areas are not in control. A sidelight advantage is that the Vice President of Manufacturing does not like to have any of the red lights on, especially since other vice presidents are often in conference in his office; questions usually arise if the lights should be on! Jokingly, it has been said that, "he doesn't care whether or not we are in control on quality just as long as the red lights are off." This, of course, has a tremendous psychological advantage.

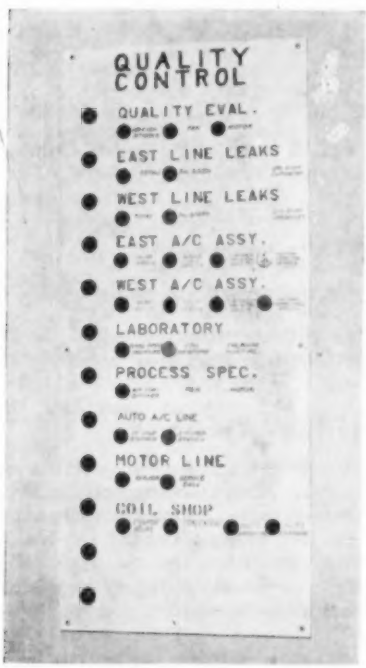

Figure 2—This board, located in the offices of the vice president of manufacturing, production superintendent, and quality control, lights up when the quality control inspector indicates quality out of control.

The production personnel on the line demand a stream-lined communication system; naturally they do not want to be called on an out-of-control condition if they do not know the specific reasons and have not taken definite action. As a result, the production leadmen and foremen make it a habit to review the inspectors' reports at every opportunity to see whether or not they are well within control. In turn, the inspectors cooperate by advising production personnel when a series of repetitive defects occur so that action can be taken "before the light goes on in the boss's office." Simple as it may seem, the red light plays an important part in the notification of the line personnel to get the job done on time. In most cases, an out-of-control condition exists because of defective material or workmanship; and if the fault is isolated quickly, it can be remedied just as quickly. Sometimes a problem exists because of design, in which case, product engineering is given the facts and cooperates in bringing about a correction. Thus, rather than "living" with an abnormal rate of defects, the system automatically brings about a correction. In 95 percent of the cases, the problems are handled at the line level; only occasionally is a push from a higher level necessary.

In addition to the controls on each assembly line, control limits have been set on Quality Evaluation, the Quality Control Laboratory, and Process Inspection. A brief explanation of these three categories follows.

Quality Evaluation

Each day products are taken from the assembly line and checked completely for quality defects. Each defect is rated by a demerit system, and a control limit has been set on the maximum demerits allowed. When the demerits exceed the upper control limit, the light goes on showing that the outgoing quality level is below the standard. This is an audit not only of the production personnel, but on the inspection personnel as well. This is a very handy tool for the quality control supervisor to determine the effectiveness of the inspection function. When the quality evaluation category is out of control, immediate action is taken to correct the fault.

Quality Control Laboratory

The quality control laboratory category is shown to be out of control whenever a lab test reveals excessive moisture, excessive contamination, incorrect refrigerant charge, or any other condition normally checked by lab procedures. As an example, heat transfer surfaces are taken from the coil shop daily and checked for residual moisture. Acceptable specifications are set and if exceeded, the control light on the lab is turned on. By this means, the serious problems are always highlighted and receive prompt attention.

Process Specifications

The category of process specifications covers all plant processes required in the manufacture of the product. A process specification manual has been written which clearly outlines the procedure to be used in each plant process. Process inspection makes the rounds daily to see that each process is being done in accordance with the manual. Such things as brazing, flow-coat painting, spray painting, hydraulic expansion of coils, heat treatment of coils, dehydration, application of adhesives, varnish coating on stators, refrigerant charging, aluminum die-casting of rotors, cad plating, etc., are covered in the process specification manual.

Whenever a process is not being performed properly, it is considered out of control and so indicated on the board. If a correction is not possible immediately, a deviation is written and authorized by the Engineering, Manufacturing, and Quality Control Divisions. Process inspection is a very important phase of the overall inspection organization. It is by this means that epidemics of rejects are avoided on the final assembly lines.

Every day a concise report on quality is issued to plant management. This report is entitled *Quality Digest* and highlights the trouble spots that were evident on the previous day of production. The one-page digest is easy to read and is especially informative to the Sales Division in that the outgoing quality of the product is clearly defined.

The system explained in this article has taken a number of years to develop into its present state. It is very effective and has resulted in a marked improvement of quality. The next time you are asked "How is Quality Today?" perhaps some of the ideas presented herein will be helpful to you in answering that question.

TABLE X—Experimental Results

through to the final report. Common to all statistical

Design of Experiments *from a statistical viewpoint*

Part II

RICHARD S. BINGHAM, JR.

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Introduction

The first part of this article which appeared in the May issue traced the planning steps a test engineer might follow in examining a problem. Stressing an objective approach, with carefully defined goals, scope and schedule, it emphasized how the statistician can best aid in defining the most suitable test layout when invited to the first planning sessions. Some of the patterns in which a factorial design might be replicated were discussed with the pertinent randomization procedure.

This part uses an example to illustrate the procedures and the interpretation of the results. Finally, mathematical models are discussed to complete the picture.

Example

Table X shows the coded results from a factorial experiment arranged in a Latin square with complete randomization of the test order. The mathematical model is:

$$y_{ijk(lm)} = \mu + M_i^F + T_j^F + (MT)_{ij}^F + B_k^F + K_l^F + E^R_{m(kl)}$$

where

μ = general mean

B = batches (k = A—D)

K = kettles (l = I—IV)

M = mixing (i = 1, 2)

T = temperature (j = 1, 2)

MT = interaction

E = error (m is a function of k and l)

F = fixed factor,

R = random factor

Calculations of Sum of Squares*

S_A = sum of squares of individual results
$= (1^2 + 6^2 + 9^2 + \ldots + 4^2) = 666$

S_C = (square of sum of individual results)/16
$= (-2)^2/16 = 0.25$

S_B = (sum of squared batch totals)/4
$= (17^2 + 8^2 + 6^2 + 21^2)/4 = 207.50$

S_K = (sum of squared kettle totals)/4
$= (5^2 + 3^2 + 2^2 + 8^2)/4 = 25.50$

S_T = (sum of squared temperature totals)/8
$= (12^2 + 14^2)/8 = 42.50$

S_M = (sum of squared mixing totals)/8
$= (15^2 + 13^2)/8 = 49.25$

S_{MT} = (sum of squared cell totals)/4 $- S_M - S_T$
$= (18^2 + 3^2 + 30^2 + 17^2)/4 - 49.25 - 42.50 = 289.25$

$S_E = (S_A - S_C) - (S_B + S_K + S_T + S_M + S_{MT} - 5S_C) = 53.00$

Formulas for the sum of squares and expected mean squares are given in Table XI; the analysis of variance in Table XII.

Conclusions From This Experiment

From Table X and Table XII it is concluded that:

1. The joint effect of temperature and mixing (interaction) negates the possibility of operating at the highest level of each. Better results are obtained at M_1T_2 or M_2T_1 than at either M_1T_1 or M_2T_2. M_2T_1 gave highest yield.
2. Batch to batch effect due to raw materials was substantial. If the experiment had been handled as a completely randomized design (ignoring both batches *and* kettles) or as a randomized block design, the error mean square would have been two to three times larger depending on the choice of batches or kettles as "blocks".

Comments About the Design

In this example, it was not possible to predetermine the sample size necessary to detect a given yield improvement with selected risks, because of the lack of

*Note that terms with negative coefficients (such as —2, —4, etc.) become positive on squaring, hence they are shown as + .)

TABLE X—Experimental Results

A. Latin Square Design

Kettle	Batch				Sum
	A	B	C	D	
I	15	1	−3	−8	5
II	8	7	−3	−9	3
III	−2	4	−6	2	−2
IV	−4	−4	6	−6	−8
Sum	17	8	−6	−21	−2

B. Data in Factorial Form

Mixing	Temperature		Sum
	T_1	T_2	
M_1	1, −6 −9, −4	−3, 4 8, −6	
	−18**	3**	−15
M_2	15, 2 7, 6	−8, −2 −3, −4	
	30**	−17**	13
Sum	12	−14	−2

**Sum

preliminary data. Once the experiment was completed, *future* experiments on this system *could be so planned*. Following the method of Kempthorne,[11] the chances of finding changes in yield as influenced by the effects "batches", "kettles", "mixing", "temperature" and the interaction can be calculated. At a five percent risk of erroneously claiming a real difference, the chances of *failing* to find an average difference among the factors is given in Table XIII. Thus, an increase in the number of replicates, or a decrease in the experimental error is needed before differences of the order found for kettles, mixing and temperature (alone) would be claimed significant.

TABLE XI—Sums of Squares and Expected Mean Squares

Source	Sum of Squares	Expected Mean Square
Batches	$S_B - S_C$	$\sigma_e^2 + 4\sigma_B^2$
Kettles	$S_K - S_C$	$\sigma_e^2 + 4\sigma_K^2$
Temperature	$S_T - S_C$	$\sigma_e^2 + 8\sigma_T^2$
Mixing	$S_M - S_C$	$\sigma_e^2 + 8\sigma_M^2$
Temp. × Mixing	$S_{MT} - S_C$	$\sigma_e^2 + 4\sigma_{MT}^2$
Error	S_E	σ_e^2
Total	$S_A - S_C$	

Conclusions

Although statistical techniques are still undergoing change, improvement, and modification, typical of the scientific method of which they are a part, there is no need for the experimenter to improvise his own statistics. The mystery can be removed from data analysis by using proven methods. There is no need to plan the tests around some *one* statistical method taken from a textbook, but rather the problem should be defined, then the test pattern chosen that best fits the requirements of the problem.

Interpretation is the important part of test planning. Here, the experimenter and statistician can achieve best results by working side by side, from the planning stage through to the final report. Common to all statistical testing and learning, proper replication brings confidence with the prescribed risk.

Mathematical Appendix

Many papers on experimental designs discuss "mathematical models" but few delve into their interpretation or verification. An elementary discussion for the factorial design is given below.

Purpose of the Mathematical Model

The mathematical model is an algebraic statement of how the phenomenon under study behaves, from the experimenter's viewpoint. It is his best estimate of the true situation, analogous in important detail. Since it is only a *model* of reality, it must not be mistaken for the real thing. The goal of the experimenter is to evaluate his model, revise it as necessary to make it more closely approximate the observable, and establish its predictability. His ultimate goal is, of course, to link together all previous knowledge on the subject into a more understandable "natural law."

TABLE XII—Analysis of Variance

Source	D.F.	S.S.	M.S.	F
Batches	3	207.25	69.1	7.82*
Kettles	3	25.25	8.4	< 1
Temperature	1	42.25	42.2	
Mixing	1	49.00	49.0	
Temp. × Mixing	1	289.00	289.0	32.7*
Error	6	53.00	8.8	
Total	15	665.75		

*Significant, claimed with 0.05 risk.

Importance of Model Formulation

Failure to include important factors can be detected statistically; however, neither their magnitude nor their distortion of the evaluation of the chosen factors can be quantitatively established. This failure to include a *main factor* in the model is usually referred to as "confounding".[8,10,12] A situation to be distinguished from this occurs when an *interaction*, or product term of two or more factors, is omitted from the model, or "pooled" with the experimental error term. This may be illustrated by comparing the two models (A) and (B) below for the data of Figures 3-A and 3-B. (See p. 32, May issue.)

(A) $\quad y = \mu + M_i + T_j$*

(B) $\quad y = \mu + M_i + T_j + (MT)_{ij}$

*The error term "e" has been omitted from the models in this discussion and should properly be added to each. This was done so replication could be omitted in the interest of simplicity.

TABLE XIII—Power of the Design to Detect Differences

Factor	Average Difference Observed	Chances of Failing To Find This Difference
Batches	2.67	18/100
Kettles	1.33	>80/100
Mixing	1.62	>80/100
Temperature	1.75	>80/100
M × T Interaction	8.5	4/1000

TABLE XIV—Comparison of Actual and Predicted Results Using Two Models

Figure*	Model	Yield Value: Predicted	Actual	Deviation
3-A	A	14.00	15.00	−1.00
	B	15.00	15.00	0
3-B	A	5.75	4.00	+1.75
	B	4.00	4.00	0

*See Part I, p. 29-34, May 1959 issue

Table XIV shows the results of predicting the yield for the treatment combination (mt) i.e., M_2, T_2, as discussed in detail below.

The absence of the interaction term (MT) in model (A) causes errors in prediction of the same magnitude as the interaction itself. (Table XV gives the size of the effects.) Although the deviations from the actual value do not differ by much, the omission of the term (MT) is more serious with the data of Fig. 3-B than that of Fig. 3-A, because in the former the interaction effect is at least twice the size of the next largest influencing effect (T), while in the latter the interaction effect is only one-third the size of either (M) or (T).

In addition to poorly predicting the outcome of these or future experiments, the use of model (A) will lead to inflation of the "error" term, by which the significance of the effects is judged. The smaller the "residuals", or deviations from observed values as predicted by the model, the lower the experimental error and the greater the sensitivity of the test. A feeling for this may be gained by considering Table XII. If "kettles" and "batches" had not been identified in the model $y = \mu + M + T + MT + K + B + E$ their effect and sum of squares would have been added to the error sum of squares with an increase of 438 percent in that term. (See section on Hyper-Graeco-Latin-Squares, Part I, for further discussion of this.)

Calculation of Treatment Effects in the Model

The "effects"* of (M), (T), and (MT) in model (B) may be calculated from the following equations:

$$\bar{x} = [(1) + m + t + mt]/4 \quad (1)$$

$$M = [-(1) + m - t + mt]/4 \quad (2)$$

$$T = [-(1) - m + t + mt]/4 \quad (3)$$

$$MT = [(1) - m - t + mt]/4 \quad (4)$$

The results are summarized in Table XV.

If we follow the rule: "subtract the effect of the variable when at its low level, add when at its high level, and use the sign of the product of variables for the interaction term," the original yield table can be reconstructed from model (B) rewritten as equation (5).

$$y = \bar{x} + M + T + MT \quad (5)$$

For example, using the results of Table XV, the value for y when $M = M_1$, $T = T_2$ in Fig. 3-B is:

$$y = 4.75 - 0.25 + 0.75 - (-1.75) = 7.00 \quad (6)$$

Relation of Design and Experimental Units

In the above, the levels and calculations of the factors are treated in "design units." This simplifies the computing since the designs and equations are universal for all 2-level designs independent of the actual experimental levels used. The conversion from experimental units may be illustrated as follows.

Given that mixing speed (M) is to be varied from a low value of 100 rpm to a high of 500 rpm, the relation between design units (d.u.) and experimental units (e.u. in rpm) can be derived: *

1. set −1 d.u. = 100 rpm
2. set +1 d.u. = 500 rpm
3. the difference + 1 − (−1) = 2 d.u. = 500 − 100 = 400 rpm or 1 d.u. = 400/2 = 200 rpm
4. the midpoint (0 d.u.) = − 1 d.u. + 1 d.u. or 100 + 200 = 300 rpm
5. therefore, if a mixing speed (M) is given, its equivalent in design units is
$$D = (M - 300)/200$$
6. or conversely, converting from d.u. to e.u.
$$M = 200D + 300$$

Thus (5) may be rewritten in experimental units:

$$y = 4.75 + 0.25\,\frac{(M-300)}{200} + 0.75\,\frac{(T-150)}{50} - 1.75\,\frac{(M-300)}{200}\,\frac{(T-150)}{50} \quad (7)$$

where

$M_1 = 100$ rpm
$M_2 = 500$ rpm
$T_1 = 100°C$
$T_2 = 200°C$

The results of (6) can now be verified in original (experimental) units:

$$y = 4.75 + 0.25\,\frac{(100-300)}{200} + 0.75\,\frac{(200-150)}{50} - 1.75\,\frac{(100-300)}{200}\,\frac{(200-150)}{50} \quad (8)$$

$$= 4.75 - 0.25 + 0.75 + 1.75 = 7.00$$

Once the model has been verified, the experimenter will want to use it to predict yield values at intermediate levels of (M) and/or (T). Both interpolation and extrapolation are subject to error; the first, because the two-level factorial designs do not take into account nonlinear response of the variables, and the second, because the response may not be linear beyond the range of variables studied. Important interpolations or extrapolations should, of course, be checked by independent tests. Davies,[8] Hicks,[10B] and Bennett and Franklin[1] have more complete discussions of mathematical models.

*The design units above are for equally spaced intervals. When there are three levels the d.u. are −1, 0, +1; when four, the d.u. are −3, −1, +1, +3. In general they are 0, ± 1, ± 2, ... when n is odd or ± 1, ± 3, ± 5, when n is even. See ref. (10A) for orthogonal polynomial coefficients.

TABLE XV—Possible Effects of Mixing and Temperature

Situation (Figure*)	Factors: $\bar{x}$	M	T	MT
1-A	2	0	0	0
1-B	4	2	0	0
1-C	4.5	0	2.5	0
1-D	6.5	2	2.5	0
3-A	7.5	3	3.5	1
3-B	4.75	0.25	0.75	−1.75

*See Part I, p. 29-34, May 1959 issue

Independence of Effects in a Factorial Design

One of the most important properties of orthogonal designs such as the factorial is that each factor is judged independently of the others. To illustrate, suppose that the addition of a baffle to the reactor increased the effectiveness of mixing at all speeds by 10 units. Thus, the data of Fig. 1-D would be increased in proportion. (The new values would be (1) = 12, (m) = 16, (t) = 17 and (mt) = 21.) Using equations (1-4) it is apparent that only $\bar{x}$ would increase (to 16.5 yield units). Thus an equal increase in *all* levels of a factor influences only the general mean and not the differential effect of the factor.

If the baffles had effect only at high speeds then the data might be (1) = 2, (m) = 16, (t) = 7, (mt) = 21. From equations (1-3)

$$\bar{x} = [2 + 16 + 7 + 21]/4 = 11.5$$

$$M = [-2 + 16 - 7 + 21]/4 = 7.0$$

$$T = [-2 - 16 + 7 + 21]/4 = 2.5$$

Hence, $\bar{x}$ and M changed but not T. If equation (3) is written so that the increase due to baffling is shown—as in (9) below—it becomes apparent that changes in yield due to mixing will not have any effect on the influence attributed to temperature. The underlined portion is that due to the increased effect of mixing.

$$T = [-2 - (6 + \underline{10}) + 7 + (11 + 10)]/4 = 2.5 \qquad (9)$$

This ability is not limited to factorials but is present in all *orthogonal* designs. It provides the basis for removing the effect of batches and kettles in the example.*

*See Cochran and Cox[6] p. 62-63.

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Part III — Case Histories

THOMAS A. BUDNE*

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Editorial Note

This is the conclusion of Mr. Budne's article. Part I appeared in the April issue and Part II appeared in the May issue.

Nothing additional in the analysis of the data will be learned from case histories. The synthetic example was modeled very closely to situations arising in actual experience. There are, however, other lessons to be learned in the planning and execution of such screening experiments.

Case History—Plastic Film

One experience relates to a manufacturing operation consisting of the extrusion of plastic material into very thin film. The problem was one of excessive breakage in the continuous film between the extruder and the roller on which the film was wound.

The first part of the problem was getting a reliable measure of the magnitude of breakage. This in itself required study. It was found that counting the number of breaks in a fixed time period was not a sufficiently sensitive measure unless the time period was made impracticably long. A satisfactory measure appeared to be the average time between the first three breaks, but terminating the test in any event after a fixed time. The problem was so severe that the exact measure for runs with a long time between breaks was not essential. Thorough investigation led to a list of suspect variables. They were:

1. Zone 1 extruder barrel temperature
2. Zone 2 extruder barrel temperature
3. Zone 3 extruder barrel temperature
4. Upper die temperature
5. Lower die temperature
6. Flow rate of screw cooling water
7. Temperature of screw cooling water
8. Screw speed
9. Take-off speed
10. Volume of air blown at extruded film
11. Room temperature
12. Room humidity
13. Lot-to-lot differences in plastic material purchased
14. Amount of additive combined with plastic in extruder hopper

Other variables such as die size and die opening among others were excluded for the simple reason that an extruder using a fixed die opening and the same die would show large variation in the severity of the break problem. Obviously, differences in dies or die openings could not create this variation. If the variables affecting the variation could be identified, the problem could be solved. Careful study of records and operations helped establish upper and lower "experience" limits for each of the variables. The lot-to-lot variable was another type of problem. For this, four lots were selected at random and designated by a letter code.

The design for 32 test runs was laid out exactly as described in the synthesized example for the first 12 variables. With a high and a lower level for each in accordance with the "experience" limits. The four-level lot-to-lot variables and the two-level additive variable were combined in a 2×4 factorial with four replicates. These 32 combinations were randomized with the other 12 variables. Since the experiment was to be run as part of the normal manufacturing operation to produce salable product, the production manager was, of course, greatly concerned that his manufacturing operation was being turned into a laboratory which would affect his production schedules. The factors which allayed his fears were: First, at no time during the experiment would machine settings or other manufacturing conditions be different than they had been in the last three months. It was not a question of experimenting with new manufacturing conditions, but rather one of really evaluating current manufacturing conditions. Secondly, he had the problem now and could look forward to a possible solution without undergoing added losses.

At a group meeting, all operating and technical personnel who had any interest or participation in the execution of the experiment were carefully briefed on the need for the experiment, the manner in which it had been designed, the manner in which it would be analyzed, the kind of results that could be expected and all the thinking which had gone into it. They were shown

*The writer is indebted to members of the staff of Rath & Strong, Inc., with whom he was associated during the initial preparation of this article, for their valuable suggestions and criticisms.

the need for careful control of the experimental conditions and the recording of all facts which could influence the test results in any way. Suggestions from among the participants were incorporated into the plan of execution. The meeting helped foster a spirit of mutual understanding and cooperation and a desire for individual participation.

The experiment ran for four days with a tremendous interest by all concerned in the progress which could be watched in the sequential plotting of points on the scatter diagrams for each variable.

About midway through the experiment, two very critical variables began to show their effects. A third critical effect, an interaction between two variables, showed itself at the final analysis.

Normal operations were resumed with indicated changes in and control over the four critical variables with the result that the extruder, which had averaged one break per ½ hour prior to the experiment, was able to run for entire shifts without any breaks at all. It averaged approximately one break per 8-hour shift.

Other measured properties of the film, which was sampled during each run, were affected, though less critically, by one or more of the isolated variables. Among those properties affected, one was affected adversely. However, an additional variable, not affecting breaks did critically affect this same film property. Subsequent small scale experiments based on fully balanced designs, incorporating the critical variables, led to optimum operating conditions for the break problem as well as for best film properties.

Case History—Chemical Laboratory Analysis

In another case history, a testing laboratory found itself with a serious problem of being unable to reproduce test results on the same sample.

The problem concerned itself with a routine test analysis of a chemical product. Normally, 16 samples were analyzed simultaneously in four test runs each day. The test results showed severe within-run variation as well as large run-to-run variation.

Careful observation of the analytical procedures indicated the following sequence of steps which could be sources of variation:

1. The 16 samples of about five grams each were heated for ten minutes with stirring, in beakers containing a fixed volume of a solvent.
2. The undissolved portions were collected on a filter material in 16 separate pieces of vacuum filtering equipment.
3. The 16 filters were carefully washed down with an arbitrary volume of water.
4. The desired ingredient, remaining in the filter was extracted by washing down the filter with a fixed volume of a second solvent in the same vacuum equipment.
5. The collected filtrate was transferred to tared evaporation dishes which were placed over a steam bath until all the liquid was evaporated. The dishes were removed from the steam bath as they became dried.
6. All 16 dishes were placed in forced draft ovens containing three shelves for a period of about 20 minutes to dry the outside surface of the dishes and to complete the evaporation, if not already completed.
7. The dried dishes were placed into desiccators awaiting cooling so that dishes could be weighed.

It was indicated by observation and checking that technician error in weighing and measuring fixed volumes of solvent could not be responsible for the problem.

However, the following variables remained a possible source of variation on each step (levels for an experiment are indicated):

1. A. Amount of sample—2 levels
   B. Amount of heat—2 levels
   C. Amount of stirring—2 levels
2. D. Differences in the 16 pieces of vacuum equipment—16 levels
   E. Differences in sources of filter material—2 levels
3. F. Volume of water in washing—2 levels
4. None
5. G. Degree of dryness after evaporation—2 levels
   H. Degree of exposure of dried dishes—2 levels (Desiccation vs. open exposure)
6. Oven position differences:
   I. Top, middle, bottom shelf—3 levels
   J. Left, center or right side of oven—2 and 3 levels
   K. Front or back of oven—2 levels
   L. Length of oven cycle—2 levels
   M. Effects of differences in oven load—2 levels—with or without added dummy load
7. N. Amount of time in desiccator—2 levels

The 14 variables, A through N, were programmed into a random balance design of eight runs. Two runs per day, every other day, with one run in the morning and and the other in the afternoon would allow any unprogrammed variable to show its effect in run-to-run differences. By starting on a Monday, the last run would be made on a Monday, seven days later. A sufficient quantity of homogenous product (well-mixed) to fill the requirements of 124 samples was set aside.

The data were to be analyzed sequentially as each run was completed with the possibility that the critical variables would be found within three or four runs. This required that the design of each run be an independent Random Balance design containing all the levels of each variable. This was possible for all but the variables L (oven cycle) and M (oven load) since there could be reasonably only one oven load per run without introducing extreme complexities into the execution of the experiment. To avoid confounding with morning and afternoon runs, these variables were designed into a $2 \times 2 \times 2$ factorial for runs. (See Table XIII.)

High reproducibility between Runs 1, 2, 3, and 4 would eliminate these three variables as possible causes of large run-to-run differences.

Within each run of 16 tests:

Variables A, B, C & E were grouped in a 2^4 factorial design

TABLE XIII

	L+		L−	
	M+	M−	M+	M−
Morning	Run 1	Run 7	Run 3	Run 5
Afternoon	Run 6	Run 4	Run 8	Run 2

Variables F, G, H & N were grouped in a 2^4 factorial design

Variables I, J and K were grouped in a $3 \times 2 \times 2$ factorial design with the remaining four tests assigned at random to a center position of variable J on the bottom and top shelves.

For each run, these three groups of variables were independently randomized with the 16 pieces of vacuum equipment, variable D.

The first two runs indicated, and the second two runs supported the three facts:

1. there were very strong effects due to filter material differences, variable E;
2. there were two pieces of vacuum equipment which gave abnormally low test results, variable D;
3. there were severe differences attributable to oven positions, I, J and K.

The two vacuum positions were found to have badly chipped edges in parts of the glass equipment, thus allowing leaks in the vacuum system and hence incomplete extraction. Careful examination of the other vacuum units showed existing but less severe leakage. These were corrected.

Measurement of air volume passing through the various points of the forced draft oven showed major differences. Modification of air passage holes and baffle plates substantially reduced these differences.

Two additional test runs with the conditions corrected as described above and eliminating the less effective brand of filter material failed to show any other strong effects. Together with the last two runs, the variation in test sample results was reduced to 50 percent of its original variation (in terms of standard deviation); no run-to-run differences were found. It was concluded that run-to-run differences had been caused by filter material differences in runs as well as by the concentration of evaporating dishes in one section of the oven in one run and in another section of the oven in another run. Since other types of samples were dried simultaneously, the dishes were rarely distributed throughout the oven.

While variation had been reduced to a very acceptable level, questions of optimum filter conditions, optimum drying conditions and best filter materials required further study in the future. There was no need to worry about the effects of any other variables studied in the experiment.

Both of the case histories come from situations involving proprietory information limiting the availability of additional detailed information and data for publication.

Case History—Real Data

An illustration of a real set of data in a Random Balance designed experiment is given below without a description of the variables or product other than that the problem was one of product development in which the effects of different variables on the product characteristics were evaluated to find those which were the critical few. There were conditions, peculiar to this situation, which dictated the use of three levels of each of the variables. A Multiple Balance design was used, randomizing five $3 \times 3 \times 3$ factorial designs in 27 tests.

The scatter diagrams in Fig. 13 show the data for only one of the product characteristics measured. As is clearly indicated, the experiment was a definite success. The effect of variable J was so strong that the objectives could easily be achieved without further interest in any other variable.

However, for purposes of further exploration into analytical techniques which may be useful for Random Balance Designs, the following considerations may be of interest.

The variables were grouped as follows into the $3 \times 3 \times 3$ factorial design with indicated mean squares for the three factor interaction which would serve as the residual variation:

C, D, & E: M.S. (CDE)	= 16.8	(nothing significant at the 5 percent level)
F, G, & H: M.S. (FGH)	= 8.5	(nothing significant at the 5 percent level)
I, J, & K: M.S. (IJK)	= 1.1	(J and K effects are significant)
L, M, & N: M.S. (LMN)	= 6.2	(N effect is significant)
O, A, & B: M.S. (OAB)	= 5.0	(O effect is significant)

The $3 \times 3 \times 3$ blocks containing the strongest effects have the smallest mean squares. This suggests that it would generally be advantageous to group the most suspected variables into one block. This offers the advantages of the full factorial design in the most important block, yet allowing an opportunity to catch one of the less suspected variables in the other blocks if it happened to have a strong effect. In the usual factorial design, such unsuspected variables remain unpro-

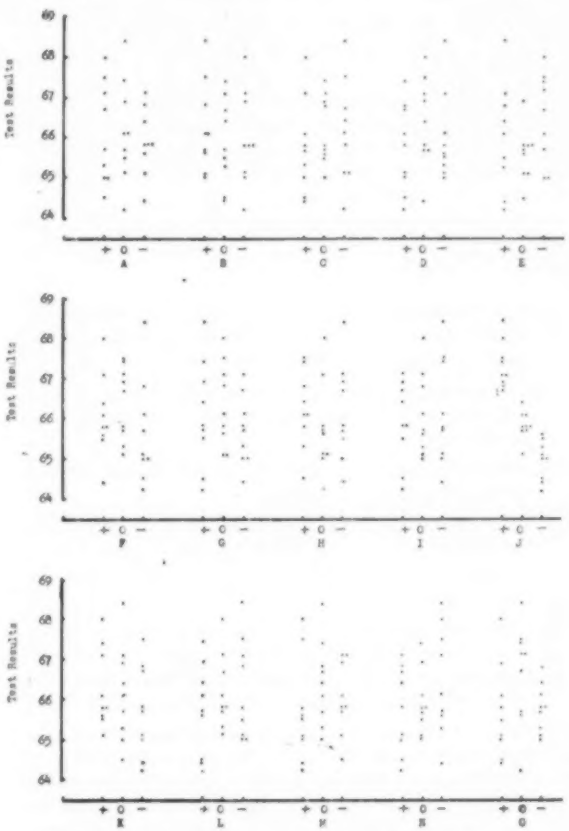

Figure 13—Scatter Diagrams of Original Test Results in a True Case History

grammed in the experiment and contribute to a major portion of the residual variation while remaining unidentified.

Summary

Although there has been no earlier publication which fully discussed the Random Balance design and its underlying philosophy, much verbal discussion and disagreement has taken place. This writer believes that much of the disagreement arises from the lack of opportunity of the dissenters to see the Random Balance technique as it really is, with its advantages and limitations. It does have both.

Any well-planned and well-designed experiment offers risks of failure and assurances of success. All these may be pre-determined in advance of the experiment. These risks have been associated with the failure to recognize an effect which exists or with the identification of an effect which does not exist—*among the variables studied*. The question as to whether the correct variables are being studied in a fact-finding situation, raises the risk of *real success or failure* to large and unmeasurable magnitudes. However, this has generally not been considered, as a "statistical risk." While this risk may or may not be a concern of the statistician, it is always a concern of the cost-conscious executive and of the problem-plagued technical and production men.

In this area, the Random Balance technique fills a void which has always existed in available statistical techniques. It will be a further monumental step of statistical progress to say that "we are 95 percent confident that the major sources of a problem can be isolated by a properly-designed experiment."

The Random Balance concept, created by F. E. Satterthwaite,* is a major step in this direction.

*Satterthwaite, F. E., "Random Balance Experimental Designs," *1957 Middle Atlantic Conference Transactions*, ASQC, Philadelphia, Feb. 1957.

SUPERVISOR'S CIRCLE

PAUL A. ROBERT, *Editor*

Precision Products Co. of Cincinnati, Box 130, Norwood 12, Ohio

Work Simplification

Applied to Inspection

Part II

ELMER N. BARRY

In Part I of this article, the benefits of work simplification were pointed out along with a discussion of the factors affecting the choice of work to simplify, the importance of obtaining all pertinent data, and the desirability of obtaining the cooperation of affected employees. We are now ready for the "microscopic" examination of the job.

STEP V—Question Every Detail

The possibilities of simplifying work can easily be brought to light by an examination of the inspection operation through questions. The development of a questioning attitude with emphasis on objective answers is a tool that many supervisors use very successfully, not only in Work Simplification but in their everyday work routines. The following check list has been used effectively in prodding the imagination on many inspection jobs, however, it may be desirable to develop such a check list which applies specifically to your type of operations.

Inspection Methods Improvement Check List

1. Is it possible to eliminate this inspection?
2. Are the limits of inspection too severe? Are they severe enough?
3. Is this the proper inspection point for this operation?
4. Where should this inspection take place? Why?
5. Has the proper chair been provided for the operator?
6. Is it possible to weigh parts instead of counting them?
7. Could the inspection be performed by means of an electric eye?
8. Can more than one part be inspected at one time?
9. Can the inspection be performed in transit?
10. Has adequate lighting been provided?
11. Can this inspection be overlapped with another operation?
12. Is this inspection complete enough?
13. Can a magnifying glass be used to advantage?
14. Would the natural light be better in another location?
15. If the inspection requirements were changed on a previous operation, would it make this operation easier to perform?
16. Can stationary gauges be used to perform this opation?
17. Can this inspection operation be performed by a machine especially suited to the purpose?

Editor's Comments

This is the final part of a two-part article on the subject of work simplification. Part I of Mr. Barry's article was presented in the May 1959 issue of *Industrial Quality Control*.

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18. Would use of a colored background aid the operator in the performance of this inspection operation?
19. Have unnecessary limits been prescribed on an unimportant operation or an unimportant part?
20. Have definite inspection standards been established in writing?
21. Is the first piece inspected by the foreman or the set-up man?
22. What influence does the value of the material have upon inspection?
23. Would redesign of the part eliminate inspection?
24. Is the proper equipment available for inspection?
25. Has the operator been properly instructed in the inspection procedure?
26. Are the gages picked and set to minimize operator error?
27. Are the gages unhandy to use because of their weight or form?
28. Do inspectors like or dislike the checking of this part? Why?
29. Is the material handled in the most efficient manner?
30. Is the proper grade of inspector doing the work?
31. Is the work done in the proper sequence?
32. Could several dimensions be checked at once by means of a combination gage?
33. Are dimensions being calculated which could be stated on the print?

STEP VI—Develop New Method

As each detail of the job is questioned a new simpler method will undoubtedly evolve. In developing the new method it is important to:

1. Eliminate all unnecessary details.
2. Combine details where possible.
3. Determine the easiest work sequence.
4. Keep the inspectors manual motions as short and as effective as possible.
5. Keep materials and equipment in most handy position.
6. Use fixtures instead of hands as holding devices.
7. Use "drop delivery" if part will not be damaged.

STEP VII—Install New Method and Follow Up

When you are ready to install the new method it is again desirable to consider the employees involved and invite the participation of some affected inspector in installing the new method. Each of us resents a change in our routine, especially if it is suggested by someone else in a "back seat driver" approach, so finesse and diplomacy at this point are all important. You should have the installation well planned to point out the benefits to the employee. Changes which affect other departments should be discussed with those affected and possible difficulties ironed out in advance. Here again, a good job of communication can make the installation more acceptable to all concerned.

Finally, follow up on the new method to insure that all anticipated savings are being realized and that if minor problems have arisen, they are solved economically and with dispatch. It is beneficial if a review of the savings on the operation can be made to keep score on your progress as well as help you evaluate various methods of approach. Certainly a record of the results will be interesting to your boss and will point out to him the interest and initiative you are displaying in reducing costs. After all, don't be afraid to tell your boss how good you are, probably no one else will, and remember,

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BOOK REVIEWS

W. D. Baten, Editor

26 University Drive, East Lansing, Mich.

QUALITY CONTROL EXERCISES by Theodore W. Bayler. (To purchase this book contact T. W. Bayler, 5836 Barrett, Detroit 13, Mich.) Reviewed by Guy R. Benson, The Upjohn Company.

A work book of this type should certainly be a welcome aid for instructors and students for courses in basic quality control. It can be used very successfully in short courses but I believe it will have more value as a daily work book in a basic college course in conjunction with any basic text.

The book is divided into ten different sections. Emphasis is put on the sections dealing with frequency distributions, distribution curves, X and R charts and attribute sampling techniques. Each problem usually has several parts pertaining to one set of data.

Most of the problems use numbers with no specific measurement indicated, which is a good idea for an exercise book in quality control particularly for a beginner. The imaginative instructor or student can make these problems real by assigning to the numbers some unit of measure such as temperature, weight, lineal measure, etc., which are familiar to the class or individual.

I believe one suggestion to make better use of the book would be to make the table of contents more specific so that the instructor can find the type of problem which he wishes to use without having to search through the context.

HANDBOOK OF PROBABILITY AND STATISTICS WITH TABLES by Richard Stevens Burington and Donald Curtis May, Handbook Publishers, Inc., Sandusky, Ohio, 1953. Reviewed by Fred A. Bacler, Western Michigan University.

In the words of the authors: "It is the purpose of this book to provide in a small, convenient size a pocket handbook of probability and statistics, sufficiently comprehensive to fill a broad variety of needs, and yet simple enough in its structure to permit use by people having a wide difference of training, background and experience."

This book is intended as a convenient summary of theory, working rules and tabular material useful in practical problems in probability and statistics. It brings together information which is not otherwise readily available in simple form except by reference to numerous journals, tables and treatises on the subject. The book is divided into two main parts. The first part includes a summary of the more important formulas and definitions of elementary statistics and probability theory. The second part consists of tables of distributions and other quantities of frequent use in statistical work."

The usual parametric tests of significance are in the book but it is unfortunate that some of the non-parametric tests are not included. The section on sampling inspection and control charts is sketchy. On the other hand the indexes by names, symbols, and by subjects should make the book easy to use. The definitions, theories, and procedures are clearly and concisely presented. It is the reviewer's opinion that this handbook should be a useful summary of information for people working in the field of statistics.

PLANNING OF EXPERIMENTS by Cox, D. R., John Wiley and Sons, Inc., New York, 1958, 293 pages, $7.50. Reviewed by Theodor D. Sterling, University of Cincinnati.

Perhaps one must be steeped in the tradition of English Empiricism to weld experimental philosophy so expertly to statistical considerations that the seam separating the two becomes invisible. With the possible exception of Tippet and his perchant of reporting periodically on statistics, Cox stands in a unique position. The fact of the matter is that the book could serve just as well for an introduction to philosophy of science—and an excellent introduction at that—as for a thorough discussion of the basic ideas in experimental design, seen from the viewpoint of statistics. Reading the book, one can not help but be convinced that, as a subject matter, statistics stands well distributed on its own foundation.

To begin with, Cox eliminates the tedium of mathematics. To quote him in his introduction: "I have tried as far as it is possible to avoid statistical and mathematical technicalities . . ." Technicalities indeed! Nowhere in the book is an equation or a formal sequence of reasoned steps given in any other than intuitive form. True, the reader should be conversant with basic concepts in statistics and have, perhaps, absorbed sufficient mathematics to talk knowledgable about functions. Yet, and despite the lack of formal preparations, Cox manages to discuss intelligently, without loss of meaning and without degrading the subject matter, such topics as the relation of covariance to randomized blocks, estimation of treatment effects in incomplete block designs, orthogonal partitions of Latin Squares, confounding, and sequential decision procedures, to quote just a few. He who thinks that to do so is easy, may wish to try his hand on the task.

The second striking feature about the book lies in Cox's choice of examples. The discussion is subtly built around and illuminated by the choice of 91, well selected experiments and the detailed analysis of their pertinent features. One must admire the ease with which Cox discusses anything from fertilizers (6.1) to false teeth (10.8) or how he manages to approach nuclear physics (8.6) with the same reverence as sewage (3.1). Cox does indeed, present a cross-section of the field of research from A (for agriculture) to Z (for zoology). For those who may need it, here again is demonstration of the independence of statistics from other disciplines or, equally, of the mutual dependence of formal developments in statistics and empirical aproaches. Certainly the work will disturb the reverie of those who claim for statistics no more than a niche in the domain of formal mathematics. Equally well it should come as rude awakening to the aspiring Ph.D. in a science who seeks to avoid mathematics by studiously applying himself to courses in the College of Education. The book is certainly above the kin of the latter while the former may gain a measure of instruction as well as of entertainment.

In short, Cox has written with eminent success for the experimental scientist, whatever his field of competence, and for the applied investigator, regardless of his specific endeavor. The reader's background should contain a modicum of quantitative training, some appreciation of statistical terminology (he should know about error variance, regression, and partitioning of sums of squares and cross products), and a desire to do better than hack work. A good stiff course in statistics and experimental experience should suffice for understanding. From this point of view the book should lend itself famously as additional reading material for a standard course in applied statistics at the graduate level or it may even form the basis of a seminar on research design in its own right.

Cox introduces the logic of experimental design in the first chapter, proceeds quickly and succinctly to the role of errors in analyses, follows with an excellent apologia on the whys and wherefores of randomization (including when a systematic design may be preferable) and concludes with an enlightening dissection of factorial and allied designs. All topics are supplied with references for more advanced readers or for those few who always yearn to apply with practicality. The last chapter deals with special topics which apparently have been collected there either because they represent special problems (as optimum allocation) or do not fit precisely into the so well organized preceding discussion but are used often enough to appear of importance (as biological assays). If it was Cox's intention to demonstrate the length and breadth of his subject matter by including the last chapter he is truly carrying coals to New Castle.

Doing all this, Cox manages to be highly readable—which is not to be confounded with easy reading. Even the more advanced student will find it necessary to apply himself with some effort. However, if it should be his aim to learn a bit about different experimental designs and their most suitable place in the scheme of things his sweat will have been well spilled.

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section briefs

AKRON-CANTON . . . On Apr. 24, the section and the University of Akron jointly sponsored an all-day seminar on the subject of QC management. Highlighting the seminar was a talk by Dr. J. M. Juran on the subject "Quality problems: definition, diagnosis, remedies, and holding the gains." Technical sessions were held in the afternoon on the subjects of: customer quality requirements, statistical techniques, job shop and gaging, and employee-management teamwork. The attendance of 102 attested to the success of this endeavor and the section is already thinking in terms of this being an annual event.

The following officers were elected to guide the section through its second year: chairman—R. W. Dorn, Timken Roller Bearing Co.; vice chairman—L. A. Bedford, Goodyear Tire & Rubber Co.; secretary—W. C. Siff, The General Tire & Rubber Co.; treasurer—O. C. Dague, The Hoover Co.

ALBUQUERQUE . . . The section enjoyed a well attended meeting on Apr. 6 with David A. Hill as guest speaker. He spoke on the subject "Drawing the line between quality and reliability." Mr. Hill has been a previous visitor to the section and following his talk a lively question period was engaged in by all members.

ALLENTOWN-BETHLEHEM . . . A joint dinner meeting with ASTE was held on Apr. 24 at the Berkshire Hotel, Reading. There was a total attendance of 70 persons—23 from the section.

The guest speaker was John Pringle, Bell Telephone Company of Canada, whose subject was "Observation on interpretation of measurement data." He spoke on methods of identifying "fringe errors" which creep into measurement data due to such random causes as human error, instrument error, and sampling error. To get an objective picture of any conditions, these "fringe errors" must be identified and removed. The use of the control chart as an analytical technique for the engineer was discussed in this connection.

We were fortunate in having a man of Mr. Pringle's caliber and background as guest speaker and he presented an interesting and informative talk.

BALTIMORE . . . Irving Belson, IBM Corp., spoke on response surface analysis at the Apr. 21 meeting. He prefaced his talk with a description of some of the experimental designs used in industrial research and industry, their advantages and disadvantages, and the need for a more efficient method of multi-factor analysis.

An executive committee meeting was held at the Johns Hopkins University Faculty Club on Apr. 30. The extension of this year's successful QC basic training course was proposed for the year 1959-60. Dolph Taylor was assigned the task as committeeman to formulate the program. Gordon Baines was given the assignment to organize seminars on the subject of reliability.

BOSTON . . . The combination annual meeting and social evening was held on Apr. 9. All efforts were expended to please the ladies. Dr. Harold E. Edgerton gave a superb talk on the stroboscopic light and its applications.

The section sponsored the highly successful reliability symposium on Apr. 16-17 at the Hotel Statler-Hilton. The list of speakers included such QC notables as Warren Purcell of Raytheon Mfg. Co., Dorian Shainin of Rath & Strong, and C. E. Fisher of Bell Telephone Laboratories. The assembly was further graced by the appearance of the honorable Foster Furcolo, governor of Massachusetts.

BUFFALO . . . The Mar. 30 meeting featured an excellent dinner talk on "What industry expects of a QC engineer" by Marsh B. Gwynn of Eastman Kodak Co. A significant response to Mr. Gwynn's excellent talk was detected from the number of questions asked during the discussion period.

SECTION CALENDAR

Dallas-Fort Worth

July 9; Chance-Vought Aircraft Co., Dallas; 7:00 pm, plant tour.

Hartford

July 7; Nutmegger House; 5:30 pm; executive committee.

Kansas City, Mo.

July 18-19; Millsite Landing Resort, Lake of the Ozarks, Gravois; bus leaves KC at 1:00 pm on July 18; field trip, visiting Bagnell Dam Hydroelectric Station and Gatlin's Boat Yard.

BUFFALO—The recent Western Electric tour was a great success. A few of the host and hosted (left to right) were: A. R. Haven; J. L. Fonagy, Western Electric; D. A. Simpson, manager of QC, Western Electric; F. E. Randall; W. F. Kubisty; V. B. Shelburne; and A. Stein.

There are 24 students enrolled in the basic QC course being jointly sponsored by the section and D'Youville College. J. L. Giocle is course instructor.

The Apr. 27 meeting consisted of an excellent tour of the Western Electric Co.-Tonawanda and election of officers for 1959-60. Approximately 70 members and guests were entertained by Western Electric and a good time was had by all.

The incoming officers are: Norman C. Hodge, chairman; Alvin R. Haven, vice-chairman; Joseph L. Giocle, secretary; Vernon R. Grom, treasurer.

The section awarded a one year ASQC membership and a text on SQC to Harold Holman and James Vedder at the recent commencement exercises at the University of Buffalo.

CHATTANOOGA . . . A full and active program has been planned for the coming year. It includes meetings on basic and advanced QC principles, a field trip, and local applications of QC.

CINCINNATI . . . A very successful joint meeting was attended by members of the Cincinnati and Hamilton-Middletown sections at the Anthony Wayne Hotel in Hamilton on Apr. 8. E. E. Stephenson, Sutherland Paper Co., gave an interesting talk on "Management and administration for quality production." A very informative question and answer period followed his speech.

Over 40 members assembled Apr. 22 to tour the new American Can Co. plant in Blue Ash. Many new and modern facilities were explained and shown to the guests.

CLEVELAND . . . On Apr. 3 a large crowd turned out to hear Dr. William H. Kruskal, University of Chicago, speak on the question, "Is sampling over-emphasized?" Dr. Kruskal discussed the statistical importance of understanding the meanings of population quantities that are estimated or tested by more or less conventional methods.

On Apr. 14 educational chairman H. M. Wadsworth started the spring educational program. A course in "Fundamental statistical sampling" lasted for six weeks. In addition to Mr. Wadsworth, Dr. J. N. Berrettoni and B. L. Hansen helped train those taking the course in a practical knowledge of statistical attributes and variable and reliability sampling procedures.

COLUMBUS . . . The Mar. 18 meeting featured Burr Stanton of General Electric Co. Mr. Stanton described a method for controlling all the factors that enter into quality production, design, machine tooling, operation of equipment under controlled conditions, and auditing of produced materials. An interesting question and answer period followed the meeting.

During the Apr. 15 meeting held at the Southern Hotel, five members of the QC staff of the new Western Electric Co. plant gave talks on training, inspection procedures, gaging equipment and other quality aspects of their company. Following the meeting, members engaged the speakers in an intresting discussion period.

Officers for 1959-60 are: chairman—Donald E. Seelbach, Denison Engineering Div., ABSCO; vice chairman—Emery Gill, Kimble Glass Co.; secretary—James A. Nimz, USA Columbus General Depot; treasurer—Fred Nicklaus, Timken Roller Bearing Co.

CORNING-ELMIRA . . . The section wishes to express its thanks to Dr. Milton Terry of the Bell Telephone Labs for his interesting talk on "The use of computers in industry" on Apr. 14. Sixty members and guests, including several members of the local section of the National Association of Accountants, were present.

Your copy of the 1959 Annual Convention Transactions is waiting for you!

If you were unable to attend this year's convention, you won't want to miss the opportunity of obtaining the vast amount of technical information presented. A limited number of copies of the convention transactions are available on a "first come—first serve" basis. Keep your quality control library up-to-date. Order your copy today!

here is a list of the papers contained in the 1959 Annual Convention Transactions

- Implementing SQC Techniques with Modern Data Processing Equipment
- Evaluating Inspection Costs
- Quality Control Charts by Gauging
- Experimental Designs and Analysis of Variance
- Statistical Procedures Applied to Processed Fruits and Vegetables
- What ASQC is Doing for the Quality Control Engineer
- The Reliability Efforts of Test Engineering at the Air Force Missile Test Center
- Quality Control in Rubber Manufacturing
- Bulk Sampling
- Transformation of the Independent Variable
- Production Vibration Processing
- Standardization of Quality Control Terms and Symbols
- Reliability, Quality Control and Simulation
- Quality Control and Reliability of Military Equipment
- Latent Reliability—An Approximation Method
- Process Control of Continuously Extruded Product
- On Sampling Inspection Plans
- Progress in Air Force Quality Control
- Management of Convair-Astronautics Reliability Programs
- Quality Assurance Environmental Testing
- Total Quality Control
- Process Control of the Continuously Extended Product
- Sensory Testing
- A Five Variable Multiple Correlation Study on Univac I
- Ford's Quality Audit Program
- Quality Control Applications in the Oil Refining Field
- Multiple Correlation for Processing Quality Control Data on a Digital Computer
- Quality Problems Encountered in the Naval Nuclear Propulsion Program
- Quality Control "from the Ground Up"
- Air Force Quality Control Activity in Reliability
- A Statistical Quality Control Approach to the Selection of Flavor Panel Members
- Vendor Quality Rating Procedure
- Navy Progress in Quality Control for 1958
- Continuous Forecast Correction in Planning Production in the Apparel Industry
- The First Four Moments of a Frequency Distribution and a Plot of the Distribution
- Randomized Incomplete Blocks
- Quality Engineering Applied to Incoming Material
- Control of Quality of Sheet Metal Materials for Containers
- Sensitivity and Efficiency of Experimental Design
- Use of Operations Research in Western Electric Company
- Quality Control Applications in the Job Shop
- The Mixed Weibull Distribution in Life-Testing of Electron Tubes
- Defense Inspection Policies as Applied to Military Subsistence
- Summary of Extreme-Value Theory and its Relation to Reliability Analysis
- Army Progress in Quality Control During Calendar Year 1958
- Food Processing Decisions by Multi-factor Analysis
- An Organized Approach to Reliability
- An Industrial Engineer Looks at Statistical Controls
- The Challenge of Reliability
- Quality Control Engineering in New Design
- Will He Take It?
- Quality Control Applications in Stampings, Welding and the Job Shop
- Specific Quality Problems in the Manufacture of Components for Nuclear Power Plants
- IBM Data Processing Equipment as Applied to Quality Control
- A Quality Control Application in the Job Shop
- Quality Control Techniques in Time Study
- Cafeteria Scheduling
- The Role of Product Engineering in Automotive Quality
- Quality Control Engineering in Product Evaluation
- Implementation of New Concepts in the Inspection of Subsistence
- Early Detection of Relatively Small Shifts in a Process Average
- Quality Control Engineering in Process and Product Control
- Machine Capability
- How Statistical Quality Control is Used in Food Processing Industries
- Polynomial Curve Fitting on Electronic Computers
- Benefits of Time Recording for Producer and Consumer
- Some Practical Applications of Sampling
- Practical Applications of Evolutionary Operation
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- Some Foundry Applications of Statistical Quality Control

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The results of the election of officers were announced. Elected "almost unanimously" were: chairman—Alan Stone, Corning Glass Works; vice chairman—Robert Myers, Westinghouse Electric Corp.; secretary—James Ettorre, Hilliard Corp.; and treasurer—Lawrence Lalor, Corning Glass Works.

DALLAS-FORT WORTH . . . G. M. Putthoff, Bendix Aviation Corp., gave a very interesting talk on "A quality assurance program using a demerit rating system" at the Apr. 16 meeting. Although the meeting had the lowest attendance of the year, those who heard him agreed that Mr. Putthoff's talk was one of the best presentations of the year. He did not deal in generalities, but presented a specific method and described its use and applications.

EVANSVILLE-OWENSBORO . . . A very enjoyable evening was had by all at the Apr. 21 meeting held at the Riverview Inn, Newburgh, Ind. The speaker for the occasion was Keith E. Ross, QC supervisor for the Essex Wire Corp. Mr. Ross spoke on "Practical aspects of sampling." He discussed the terminology of sampling, the use of such terminology in sampling, and the derivation and principles of sampling.

GEORGIA . . . The Atlanta Group made a plant visit to the Lockheed Aircraft Corp. plant in Marietta to see some of the huge planes being assembled. Following a brief talk by Floyd Castle of Lockheed's QC department, a motion picture, "Big Stick," was shown. Dinner was enjoyed in the Company Cafeteria.

HAMILTON . . . "Quality control and preventive maintenance" was the subject dealt with at the April meeting. Program chairman Stanley Manchuk, Westinghouse of Canada, was the speaker and a large number of interested guests were on hand. A number of plants in this area are at the present in the initial stages of setting up such a program, and we are all indebted to Stan for the capable manner in which he treated the subject.

HAMILTON-MIDDLETOWN . . . The interest and attendance at the Apr. 8 meeting was high. Edward Stephenson, Sutherland Paper Co., spoke on the subject "Management and administration for quality production." He cited many examples from his many years of experience in the paper industry. A number of paper industries were represented and a good discussion followed his talk.

HARRISBURG . . . The section successfully concluded the 1958-59 season with an enjoyable and interesting meeting at the Stone Barn, Millersville.

HARTFORD . . . Conrad Chilone, Anemostat Corp., spoke at an April technical meeting on mechanical pre-control. Mr. Chilone's talk dealt with a problem which faced his company—devising a simple way to control quality at the production centers. This was achieved through a mechanical pre-control board. It consists of rows of beads which the operator forms into a distribution as measurements are made. At the end of the day, the operator and the inspection department have a very good idea of the contents in the lot. (Mr. Chilone will gladly answer any inquiries on the applications of his board. His address is 15 Flower St., Hartford, Conn.)

Frank E. Grubbs presented "Accuracy, precision of measurement, product variability, and the analysis of variance" at the Apr. 1 meeting. A paper was passed out to all present showing examples and formulas covering his talk.

Executive committee members for 1959-60 are: chairman—Herbert A. France, Pratt & Whitney Co., Inc.; vice chairman—Ken Martin, Holo-Krome Screw Corp.; secretary—James Gleed, Pratt & Whitney Co., Inc., treasurer—Frederick L. Jacobs, Heublein, Inc. Chairman France invited interested members to attend the next executive committee meeting to help formulate the coming year's program.

HUNTSVILLE . . . The April meeting was held at Steadman's Restaurant. This meeting was designated as "Ladies' Night" for which there was a very fine turnout. Members and guests heard an excellent dinner talk on "SQC in engineering research and development" presented by Dr. Paul S. Olmstead of Bell Telephone Laboratories.

WILLIAM C. BROSEY

It is with the deepest regret that the Harrisburg section announces the death of Mr. William C. Brosey on Mar. 27. At the time of his death, Mr. Brosey was manager of the Harrisburg office of the General Products Division, Aircraft Marine Products, Inc. The sincerest sympathies of the section members go to his family and friends.

KANKAKEE-JOLIET . . . The section met Apr. 7 at Tony's Restaurant, Joliet. Burr Stanton, General Electric Co., spoke about "Selling QC to the factory." He also discussed GE's method of building quality into their products. To achieve quality: the product must be designed for quality; the people who will produce the product must be trained for quality; the tools to be used to produce the product must be quality tools.

KANSAS CITY (Mo.) . . . O. H. Bishop of Reynolds Metals Co. was guest speaker at the April Meeting. Mr. Bishop reviewed the quality problems encountered in producing rolled aluminum foil for household use and described the manner in which SQC procedures were used at Reynolds.

Another distinguished visitor at the April meeting was the belle of Western Electric quality control—Miss Bonnie Small. Bonnie, in Kansas City visiting Western Electric installations, received a warm welcome from her many friends.

The July meeting will combine business with pleasure. A two-day field trip to the Lake of the Ozarks has been planned for members and their families. The plans include a tour of the Bagnell Dam Hydroelectric Station and Gatlin's Boat Yard, as well as "miscellaneous activities" having to do with the Lake and the facilities of the Millsite Landing Resort. The dates are July 18-19 and the bus leaves at 1 pm on the 18th.

LOS ANGELES . . . The April meeting was a joint meeting with the San Bernardino section held at neutral ground in Pasadena. As befitted such a momentous occasion, the panel members were personalities who are not only well known but are true authorities in their fields. The topic "Reliability—its management" was covered from all aspects under the able chairmanship of Phil Reiter, Aerojet General. Les Ball presented the basic direction for management and delineated the duties that are required to be performed. Frank Squires, Topp Industries, in his usual clear and direct approach showed that if top management wants effective results, the person responsible for directing the reliability program must be statistically oriented and hence a QC man. Norm Garner, Aerojet General, showed the value of a QC or statistical engineer to the reliability program by concrete examples.

LOUISVILLE . . . A delicious steak dinner at Kapfhammer's Party House was enjoyed by 29 members and their guests at the April meeting. Our thanks to Al Goldsmith of Braseway Tubing for the cocktails before dinner. Al Green announced, and congratulated, the following members elected to fill the executive offices for 1959-60: chairman—Bob Rottman; vice chairman—Warren Allinger; secretary—Charles Martin; treasurer—Ray Evans.

Due to the splendid work of the education committee the statistical handbook is selling like "hot-cakes."

The section is presently conducting various QC courses. The date for another advanced course will be announced soon.

We were highly honored to have Dr. Paul Olmstead, consultant in engineering statistics of Bell Telephone, as a guest speaker. He displayed a portion of his wide knowledge of all phases of SQC in his subject of "Some philosophical implications of QC." We express our thanks for his discussion on QC in both production and research and development.

MEMPHIS . . . The section members were guests of the Davison Chemical Div. of W. R. Grace on Mar. 5. H. Donvan Green spoke on "Regression study on chemical specification test." After this very interesting talk there was a plant tour and refreshments.

The section held a joint meeting on Apr. 15 with the American Institute of Industrial Engineers. Dr. Harold E. Smalley, Georgia Tech, spoke on the topic "Off-beat illustrations of work measurements."

METROPOLITAN . . . On Apr. 15 a well attended and well received meeting was held at the Hotel Essex-House in Newark. H. F. Dodge, Rutgers • The State University, presented "Acceptance sampling plans—some observations." Prof. Dodge spoke about some of the requirements of an attributes sampling plan and how the Dodge-Romig plans were designed to satisfy them. He also touched upon MIL-STD-105A and chain sampling plans. The latter, prepared in collaboration with Miss Mary Torrey, make use of past information where tests are destructive or expensive and where samples therefor are small in size.

The session was moderated by M. K. Krueger of Bell Telephone Laboratories.

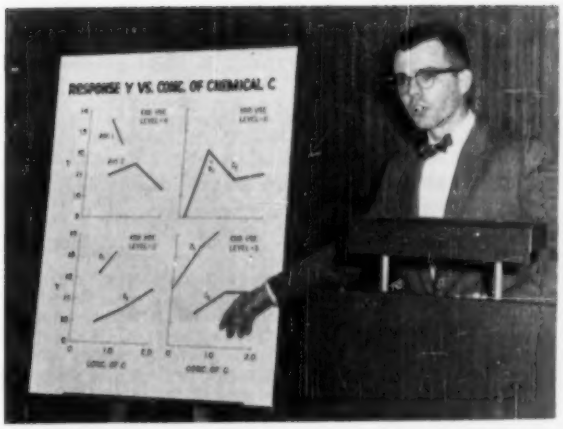
Sidney Lewis conducted the pre-meeting clinic on "Some fundamentals of acceptance sampling."

MID-HUDSON . . . Sixty-three members and guests were present for the annual joint meeting with ASTE on Apr. 14 at the Nelson House, Poughkeepsie. The coffee speaker was Jan Van Den Beemt of the IBM Patent Office whose topic was "The background of our paten. system." William McAvay,

Oakley D. Belden Conducts One-Man Membership Campaign

Mr. Oakley D. Belden of the Albuquerque section has chalked up an outstanding accomplishment this year. Not only did he join as a new member himself last fall—he brought 29 other new members into the Society during the year. The Society would like to take this opportunity to publicly commend and thank Mr. Oakley for this signal achievement; it is truly remarkable.

Think what would happen if we were all Oakley Beldens! We can't be, of course, but if each member would appoint himself a committee of one to bring in only *one* new member next year, your Society would achieve the phenomenal condition of doubling its 11,000 members in one year!



Burg Tool Manufacturing Co., was the main speaker. Mr. McAvay discussed point to point numerical control as applied to the drilling field. A film, "Burgmasters on Parade," was shown pertaining to numerical control.

MILWAUKEE . . . The April meeting was held at the Stratford Hotel and consisted of an open forum panel discussion. Panel members included George Crayeraft of Dynex, Les Eichelberger of A. O. Smith, Bill Golomski of Oscar Mayer, and Arnold Jakel, QC consultant. The panel moderator was Larry Neuman of the Miller Brewing Co. The majority of questions and discussion centered around Society professionalism and related topics such as research grants, scholarships and undergraduate curriculum. There was also a lively discussion on editorial board policy concerning publications in "Industrial Quality Control." Prior to the evening meeting and buffet supper the last of the year's dual training sessions on "Introductory probability and statistical inference" and "Design of experiments" were presented by Bill Golomski and H. Pitt, both of Oscar Mayer Co.

PENNSACOLA-MOBILE . . . Election results—Ellis Pierson of Chemstrand Corp., who has done an outstanding job in establishing the section and as chairman during the past year, was unanimously re-elected as chairman. John Comish, Brookley AFB, was elected to succeed Lt. Col. J. R. Forrester who was also instrumental in establishing the section. D. H. Dannheisser, chairman of the program committee for the past year, was elected secretary. Mr. Dannheisser succeeds B. Coleman who was appointed by the chairman to fill the vacancy created by the resignation of John Barnes. L. Trahan, International Paper Co., was elected treasurer to succeed Prof. E. A. Habel.

The section will recess for the summer months. The date and place of the September meeting has not been determined and will be announced later.

PHILADELPHIA . . . The plant visitation held Apr. 17 with tours through the Textile Research Laboratories and the Industrial Products Laboratories of DuPont was an unusual treat. It started with a short orientation and then our 55 attending members were divided into groups of five—each supplied with an efficient guide. Credit for the visit goes to R. M. Kennedy of Philadelphia Quartermaster who arranged it because research work is not generally exposed to the public due to competitive reasons.

The regular dinner meeting followed at 6 pm at the Hotel DuPont in Wilmington. The speaker was Robert Delhart of the DuPont statistical engineering group who spoke on "How the statistician aids the research chemist" and demonstrated by charts a solution to a problem by designing an experiment using analysis of variance and other statistical techniques and showing how the original design had to be modified to meet the changes in the lab procedure. (The above photo shows Mr. Delhart during the discussion.)

PHOENIX . . . The April meeting was held at the Wigwam on Apr. 10. The business meeting was conducted and the election of officers held. Harold James, director of QC for Goodyear Aircraft Corp., presented a short talk after which the group toured the Goodyear plant. The meeting was a dinner meeting with the wives in attendance and they particularly enjoyed the tour since it gave them an opportunity to see industry in action. Approximately 90 people were in attendance.

PITTSBURGH . . . The Apr. 28 meeting was one of the best of the whole year. The meeting was a special "Wives' Night." More than 50 members, wives and friends heard Miss Besse B. Day of the U. S. Naval Bureau of Ships review some of the many interesting types of problems she has worked on through the years. She also demonstrated how the ladies use certain basic statistical principles in their everyday life. The sampling of a cake by touching it at various spots was most familiar to those present. The section was most enthusiastic about the meeting and voted to have a similar one next year.

This was the last meeting at which the present officers officiated and a tiepin with the ASQC emblem was presented to section president John Hromi by Mrs. Duncan McCune, the incoming president.

PITTSFIELD . . . W. F. Bachelder, Testing Machines, Inc., was guest speaker at the Apr. 8 meeting. Mr. Bachelder's standing as a leader in the field of paper and packaging testing machines resulted in the largest attendance we have enjoyed this season. In addition to the local membership, paper industry personnel within our region received advance publicity and of the better than sixty attendees, many learned of the Society's activities for the first time. The title of Mr. Bachelder's talk was "QC testing; product and package." The history and development of the theory of testing was traced over the years with a look at the most recent developments and things to come.

Election of officers are over with the following results: chairman—Richard Powell, Sprague Electric Co.; vice chairman—William Noble, General Electric Co.; secretary—Joseph LaMountain, Bryron Weston Co.; treasurer—Joseph Trowbridge, General Electric Co. Douglas Slingerland, Peter J. Schweitzer Division, will be New England Council representative.

Metropolitan Section's "Buzz Session" Successful

The recent buzz session held by the Metropolitan section was indeed successful. These photos are evidence that the event attracts large numbers of members and guests.

A fine movie was shown of a Horrocks-Ibbotson model fishing West Canada Creek just for the holibut

. . . Dallas-Fort Worth—Tommy Howard has been promoted

RHODE ISLAND . . . At the April meeting the membership heard Dr. James H. Davidson of General Electric Co. present "Statistical methods in Russia."

The officers elected at this annual meeting were: chairman— R. Shaw Goldthwait, vice chairman—Fred W. Kolling, treasurer—Raymond B. Fournier, and secretary—Francis Bliven. Appointed committee chairmen were: membership—Joseph G. Kowalski, publicity—Alberto La Greca, education —Paul K. Moffat, and Saddoris Award—C. M. Antonio.

ROCHESTER . . . The season's final meeting on Apr. 21 was addressed by Prof. Paul C. Clifford. His topic "Control charts without calculations" presented some interesting means for simplifying shop procedures and making them easier to handle.

The annual election of officers was held. They are: president—W. Carl Jensen, Haloid-Xerox, Inc.; vice president—Wilbur C. Myers, Delco Appliance Div., GMC; secretary—Thomas J. Soebbing, Eastman Kodak Co.; treasurer—John H. Baker, Eastman Kodak Co.; executive secretary—Russell C. McCarthy, Industrial Management Council.

Thanks for a successful year are extended to the 1958-59 officers and to all who worked long and hard to achieve this success; also to the Industrial Management Council and staff, and to the University of Rochester for outstanding courtesy extended.

ST. LOUIS . . . Howard L. Stier of National Canners' Association gave a very interesting speech at the Apr. 15 meeting. His subject was "Practical appl. ations of SQC in food processing."

SALT LAKE CITY . . . The Apr. 30 meeting started with the educational part being conducted by Dr. H. E. Flanders. His subject was "The double Ogive." Referring to his experiences with open hearth and blast furnace operations, Dr. Flanders recommended the double Ogive as the best way of presenting data to operating men not conversant with statistical quantities.

Guest speaker Ed Whaley represented another comparatively new industry in our area—Hercules Powder Co. This company is rapidly expanding its Bacchus plant for research and development of the third stage of the Minuteman missile. Mr. Whaley succinctly illustrated the development of this activity, explaining in detail the function of the evaluation group made up of the QC and the reliability divisions.

Both presentations were well received. The meeting closed with a tribute to the present officers for a most successful year and the election of new officers for the coming year.

SAN ANTONIO . . . The Apr. 14 meeting was held at the Hilton Hotel with G. M. Putthoff, Bendix Aviation Corp., as guest speaker. He presented a paper and slides on the subject "A quality assurance program with a demerit rating system." A lively question and answer period followed.

During the meeting ballots were cast for election of officers. New officers for the coming year are: chairman—Porter W. Mickle, San Antonio Air Material Area (SAAMA); vice chairman—Clinton C. Brinkoeter, Freiedrich Air Conditioning Co.; secretary—Robert J. Weisbrod, SAAMA; treasurer—John R. Gilpin, SAAMA.

SAN DIEGO . . . San Diego is a "university town." A tremendous variety of courses are offered in day classes and in evening or extended-day classes on our college campuses. In addition, San Diego Junior College offers vocational and industrial classes as well as undergraduate college subjects. The section is well represented by both students and faculty. In addition to the many courses offered by the institutions of higher learning, many other classes are being conducted "in-plant" by section members. An awareness of the need for control of quality and product cost is not sufficient per se; we must also educate ourselves in the latest and best methods of effecting such control. This is our goal and we are taking giant strides towards it.

SOUTH BEND-MISHAWAKA . . . The section enjoyed a dinner meeting at the Eagles' Aerie in South Bend recently. This was the annual business meeting at which new officers were installed. Marvin Claeys of United Air Lines addressed the group on "General administrative applications of SQC."

No further meetings are scheduled until September.

SYRACUSE . . . Robert Peiffer, a section member, is teaching a weekly course in basic statistics in Watertown. The course, which began in April and will last for 15 weeks, was arranged by Russell E. Penney, New York Air Brake, who is also a section member.

The section has elected the following as officers for the coming year: chairman Frank P. Grimes, vice chairman Klare L. Teegarden, secretary William H. West, and treasurer Robert D. Green. We would like to welcome our new officers and thank our present ones for a fruitful year.

TENNESSEE . . . A fine group was on hand for the Apr. 14 dinner meeting in Knoxville. After the meal, the members and guests were privileged to hear Dr. Paul Olmstead speak on "Philosophical implications of SQC."

At the present time plans are being made for the next general meeting to be held in the early fall.

TOLEDO . . . Donald A. Brandt, director of QC for Schenley Distillers, Inc., was the speaker at the April meeting held at Angelo's.

TORONTO . . . Bob Gardno was our speaker at the meeting of Apr. 8. His interesting approach to the subject "Practical applications of probability paper" provided members and guests with many worthwhile ideas towards employment of short cuts through the use of simplified techniques. A lively and profitable discussion period followed his presentation.

A recent visit to General Motors of Canada, Ltd. on Apr. 22 was extremely well attended and provided a most enjoyable and instructive evening. Members and guests were transported through the assembly line and introduced to some of the complicated and highly organized phases of automobile assembly. The evening concluded with a question period during which light refreshments were served.

TULSA . . . The first anniversary forum held Apr. 4 at the Alvin Plaza Hotel was quite a success. Society President C. E. Fisher was the keynote speaker at the banquet honoring the founders of the section. He gave a very fine lecture on the aims and benefits of the Society. Many fine speakers were on hand to discuss topics on quality and reliability, management, and government contracts. There was also a fine book booth with upwards of a hundred of the newest and finest books on statistics, quality control, and related subjects. Our thanks go to the many fine exhibits displayed by industrial distributors in the local area.

New officers for 1959-60 will be installed at the June meeting. They are: chairman—Clyde Crenshaw, St. Louis Ordnance District; vice chairman—Jack Vanderwiede, Southwestern Computing Service; secretary—George Thelander, Douglas Aircraft Co.; treasurer—B. H. Andrews, Spartan Aircraft; section director—Don Matthews, American Airlines.

UNIVERSITY OF WESTERN ONTARIO . . . An interesting meeting was held at the YMCA in London on Mar. 11. The subject "Production views QC" was discussed by a panel composed of: Wallace Read, John Labatt's, Ltd.; John Hind, Bach-Simpson, Ltd.; Maurice D. Nicholson, Timken Roller Bearing; and Allin P. Deacon, Deacon & Associates. The panel was moderated by Andrew Grindley, University of Western Ontario.

The opening comments of the panel stirred the members and guests to express their own views on the subject. Mr. Grindley summed up the discussion by stating that the control of quality was in the hands of the production people but they must be guided by the information supplied to them by QC people.

An informal discussion with refreshments followed the meeting.

A very successful social meeting was held on Apr. 22. A short business meeting, including election of officers for the coming year, preceded the social activities. Those elected were: chairman James E. Crossman, vice chairman Leon S. Moshier, secretary David Griffett, and treasurer Grant Glennie.

To give our wives and guests a glimpse of QC, a movie on the use of QC methods was shown. A demonstration of stereophonic hi-fidelity was presented by Dominion Electrohome Industries, Ltd. and hi-fidelity records supplied the music for dancing. A buffet lunch was served following the dancing. A Deilcraft coffee table was presented as a door prize.

UTICA . . . On Mar. 10 the section held an industrial clinic for QC at the Hotel Hamilton. The clinic was a joint effort on the part of the Utica and Syracuse sections. The key speaker was Dr. Charles M. Armstrong who spoke on "Application of QC to education." The affair was attended by approximately 150 representatives of local industries.

In addition to the fine program of speakers, approximately 25 firms in the field of QC equipment displayed their latest items.

A relatively large turnout of members attended the April meeting at the Hotel Hamilton. Francis La Gase, Horrocks-Ibbotson Co., told the group how fishing equipment manufacturers have "tackled" the quality problems of glass rods. Members of the group carefully cross examined Mr. La Gase to determine the secrets of catching fish. It appears that luring fish has a probability aspect to it and there is great need in this field for carefully controlled experimentation.

. . . Pittsburgh—Ralph Maggio has left J & L Steel for a

A fine movie was shown of a Horrocks-Ibbotson model fishing West Canada Creek just for the halibut.

WICHITA . . . The April dinner meeting was held on Apr. 14 at the Oriental Restaurant. The program was sponsored by the Beech Aircraft Corp. and consisted of color sound films covering "reliability" and the "development and testing" of the Beech aerial missile target. The guest speaker was C. R. Bonnell, chief of weapons system electronics and missile engineering.

YOUNGSTOWN . . . Richard G. Patterson, U. S. Ceramic Tile Co., discussed the little known theory of maldistribution at the March meeting. Using specific examples from QC problems common to the ceramics industry, Mr. Patterson demonstrated the effective use of this theory. It is applicable to QC, time study, inventory control, production scheduling, experimental problem solving, and many other tasks. By the systematic ranking of factors in order of importance, it is seen that only a few factors possess sufficient importance to warrant complete study.

Mr. Patterson has been manager of QC of the East Sparta plant for the past year. His degree is in ceramics but he has long devoted his attention to QC. Recently, he organized and directed QC courses for the newly-established Akron-Canton section.

"Measurement through quality costs" was the subject presented Apr. 2 by H. L. Freeman of General Electric Co. Better quality at lower costs can be gained through planning, organizing, integrating and measuring all QC activities. Mr. Freeman's practical approach to the control of operating quality costs through prevention, appraisal and reduction of failures was well received by the more than two dozen members and guests from Shenango and Mahoning valley industries. Mr. Freeman said that "one dollar spent in prevention may save ten dollars in failures." He presented actual cost studies to illustrate his talk and emphasized that QC is the concern of everyone in the company.

SIGNIFICANT DIFFERENCES

. . . Allentown-Bethlehem—The following are the new officers for the coming year: chairman—Ken Stephens of Western Electric Co.; vice chairman—Paul Connolly of Dixie Cup Co.; secretary—Dick Zwickly of Parish Pressed Steel; and treasurer—Dan Serobe of Western Electric Co.

Ken Stephens has returned to Western Electric after completing advanced studies in SQC at Rutgers University.

Don Yateman has left Dixie Cup and is now with Glatfelter Paper Co. We wish Don happiness and success in his new position; we will miss him as he was one of the spark plugs of our section.

. . . Baltimore—John D. Pryor of the Catalyst Research Corp. was promoted to assistant QC manager.

. . . Boston—The section has lost its chairman-elect Martin W. Rogers who has accepted a position with RCA in Moorestown, N. J. The section's best wishes go to Marty. Present chairman Dorothea Looney has consented to serve another year.

. . . Chattanooga—New officers for 1959-60 are: chairman P. S. Deck, vice chairman V. Thompson, secretary B. E. Davenport, and treasurer J. C. Hornsby.

. . . Chicago (Calumet subsection)—The following officers were elected: chairman—Francis L. Zellner, Cities Service Oil Co.; vice chairman-program—George O. Bunch, Union Carbide and Carbon; vice chairman-arrangements—William B. Helm, Standard Forge Corp.; and secretary-treasurer—George W. Johnson, Marbon Chemical Division of Borg-Warner.

. . . Cincinnati—Wm. Barker, General Electric Co., has been elected as district 8 representative.

Bob Bescher, an enrolled student member, has completed his co-op for a B.S. degree in industrial management.

Several members employed at General Electric received promotions in the QC department. They were E. J. Kovarik, J. P. Miller, R. B. Miller, J. L. Reum, and D. E. Munro.

. . . Cleveland—Stan Freeman has joined Westinghouse Electric Corp. in Mansfield as a statistician.

Emil F. Gibian was recently appointed to the newly-created position of director of industrial engineering at the corporate staff level of Thompson Ramo Wooldridge, Inc.

. . . Corning-Elmira—Louis G. Dion, QC engineer of the Corning Glass Works, is currently spending several weeks settting up inspection and QC at Corning's new plant in Sidney, Australia.

. . . Dallas-Fort Worth—Tommy Howard has been promoted to vice president for production of the Haggar Co.

Another promotion at the Haggar Co. resulted in the promotion of C. G. (Cass) Rutkiewicz to vice president for quality control.

J. L. Coburn has been promoted to the position of chief, reliability-vendor coordination.

On Apr. 1 the section set aside over $650 in its scholarship fund. This is in accordance with the section's scholarship program.

. . . Evansville-Owensboro—The new officers for 1959-60 are: chairman Fred Wilhite, vice chairman Arnold Lochner, treasurer John Marrs, and secretary James Romerhausen.

. . . Greater Detroit—The following officers have been elected: chairman—W. J. Gallagher, Jr., Chrysler Corp.; vice chairman—Thomas L. Harvey, King-Seeley Corp.; secretary—Thomas N. DiGaetano, Parke, Davis & Co.; and treasurer—David A. Pantano, Chrysler Corp.

. . . Harrisburg—New officers are: chairman—Jim Ramsey, Schick, Inc.; vice chairman—Bob Naylor, York Div., Borg-Warner; secretary—Walter Baker, Caterpillar Tractor Corp.; treasurer—Dick Wise, AMP, Inc.

. . . Hartford—L. E. Heasley has been promoted to general factory manager of Fafnir Bearing Co.

Albert M. Dexter, Jr. spoke at the national convention of ASTE which was held in Milwaukee. Mr. Dexter's topic was "Latest developments in measuring to 0.1 millionths of an inch."

Ernest Bozenhard, formerly with Underwood Corp., has joined Standard Thomson Corp. of Waltham, Mass. as QC manager.

. . . Kankakee-Joliet—Newly elected officers are: chairman—Mary Egges, General Foods; vice chairman—John Jeffrey; secretary—Donald Dau; and treasurer—Roosevelt Begnoche.

Arthur Benscoter, QC director of the A. O. Smith Permaglas Division, has been elected district 12 representative.

. . . Los Angeles—Frank Squires, Topp Industries, conducted the AMA manufacturing workshop seminar on organization and management of QC on Apr. 20-22.

ANNOUNCING!

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September 14, 15 & 16, 1959

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EVOP COURSE

The Chemical Division and the Greater Detroit and Windsor sections of ASQC will sponsor an EVOP Course on July 17-18. Instructors for the course, to be held in Detroit, are J. Stuart Hunter of Princeton University and Truman Koehler of American Cyanamid Co.

For information write Harmon S. Bayer, Quality Control Consultant, 1154 Book Bldg., Detroit 26, Mich.

Ray E. Primmer has left Hydro-Aire to become president of QRA, Inc., a company established to satisfy the QC and inspection requirements of modern industry.

Dr. Harry G. Romig is now with Hoffman Laboratories in charge of rel..bility.

Howard Todt has been placed in charge of vendor quality at Autonetics.

Arthur J. Fernandez, formerly with U. S. Time Corp., is now QC manager, Elgin National Watch Co., Burbank. Mr. Fernandez transferred his membership from the New Haven section.

. . . Memphis—Officers for 1959-60 are: chairman J. Glenn Olree, vice chairman Frank O. Howland, secretary Jerry A. Gowman, and treasurer Raymond L. Ross.

. . . Metropolitan—Donald Macaulay, president of Paper Quality Control, Inc., recently completed a month's trip to Europe as a QC consultant visiting printing plants and paper mills. In addition, he made necessary preparatory plans for seminar courses which he will be conducting this fall.

. . . Mid-Hudson—Harry G. Harding was appointed to represent the section at the 1959 New England Conference.

Sooren Soovajian was the winner of a free dinner for obtaining the most members in the local membership contest.

. . . Omaha-Lincoln—Sam L. Grasso has been elected to vice president of Inland Manufacturing Co.

. . . Phoenix—The election of officers produced the following results: chairman W. C. Klontz, vice chairman W. E. Wagner, secretary J. Abdai, and treasurer C. E. Vermelyea.

D. Dan Casky has been appointed chairman for the Western Regional QC Conference to be hosted by the section in October.

Dr. J. Fruend has submitted his resignation as vice chairman due to a strenuous work load as head of the mathematics department at Arizona State University. Although the loss of this very active member as an officer of the section is regreted, we appreciate his continued interest in the QC field.

. . . Pittsburgh—Ralph Maggio has left J & L Steel for a position with Republic Steel.

J. De Cannio has been transferred out of the section to the Long Island area by his company, Continental Can Co.

Robert R. Wiseman has joined the Carborundum Co. at the Latrobe plant.

. . . Pittsfield—Thomas Kelly has been appointed QC supervisor at the Columbia Mill, Peter J. Schweitzer Div., Kimberly-Clark Corp.

. . . Salt Lake City—J. C. Billeter, past chairman, has been promoted to division chief of the central QC office at Hill AFB.

Mrs. Dorothy Kirton, wife of treasurer Joe Kirton, has attended most of the ASQC meetings along with her husband. At the Apr. 30 meeting she was joined by Mrs. Marian Jensen, wife of member Eldon Jensen.

We are happy to welcome two members into our midst. L. R. Ruble, formerly project officer at Hq. AMC, Dayton, Ohio is now civilian head of QC, Air Force Ammunition Office. Edward P. Whaley, Hercules Powder Co., has transferred from Poughkeepsie and is now evaluation group supervisor at the Bacchus plant.

We regret the departure of George Cohan, a strong section supporter and representative on the West Coast council. He has left the Air Force to accept employment in private industry.

. . . San Antonio—John D. Turner, section publicity chairman, completed a three week course in management of QC held recently at Hq. AMC, Dayton, Ohio. This course was made available by the Air Force Institute of Technology, School of Logistics in cooperation with Ohio State University.

Section secretary E. W. Doiron has accepted a position as chief of workload control in the directorate of logistic support management, SAAMA.

CORRECTION NOTICE

The announcement of the twelfth annual intensive course in quality control by statistical methods, sponsored by the University of Michigan, to be held Aug. 17-27 which appeared on page 14 of the April issue erroneously reported the course fee to be $15. The correct course fee is $150.

Please address inquiries to the course director, Professor C. C. Craig, 106 Rackham Bldg., Ann Arbor, Mich.

What's New?

ROY A. WYLIE, *Editor*
Ampex Corporation

P-4-11—Modifications of CEC type 21-620 Mass Spectrometer permit analysis of light liquids and gaseous mixtures over a mass range previously possible only with permanent laboratory installations. CEC offers a choice of two modifications of its new units, either of which has a mass-range reaching 300. Mass range formerly was two to 150. A "basic" modification offers a range from 24 to 300, and an interchangeable magnet can be used for mass two. A "complete" modification offers a range of 12 to 300, plus low masses of two and four with the interchangeable magnet. Both modifications will be made to order and installed at the factory. Designed for use by refineries, chemical plants and research institutions, the 21-620 now permits analysis of heavier or more complex molecules. The extended range was accomplished by equipping the cycloid tube with narrowed source slits and increasing magnetic field strength.

P-5-1—Ultrasonic Testing and Research Laboratory has announced a new ultrasonic recording system for bond testing and flaw detection. The Soltronics Sonafax system results in a permanent record of test information which places, on a practical basis, the ultrasonic inspection of brazed joints and adhesive bonded structures. Excellent sensitivity and definition are obtained from tests of facing sheet to core bond in brazed honeycomb. With the system, one to one scale recordings can be made of areas 18 inches wide and of indefinite length.

★ ★ ★

Send for Information

Additional information regarding new products or new literature items appearing in the "What's New?" department can be obtained by writing in the key number of the item in the Product Education Service coupon which appears on page 38.

P-5-2—Temperature measurements of minus 57 degrees (minus 70 degrees F) are possible with mercury-thallium filled thermometers developed especially for low temperatures by H-B Instrument Company. The mercury-thallium amalgam leaves the bore clean, eliminating the formation of condensed droplets and chemical changes typical of organic liquid filled thermometers. Reproducible readings at repeated intervals can be obtained under all climatic conditions. The mercury-thallium thermometers are furnished with a yellow back for quick, clear readings. To meet most standard requirements, they are stocked in seven models, in ranges of minus 57 degrees C to plus 100 degrees C and in lengths of 9 to 18¾ inches.

★ ★ ★

P-5-3—Exceptionally high stability is achieved in the 4 to 410 megacycle Trad Model SG-54A standard signal gener-

ator. Incidental FM is less than 300 cps at 50 percent modulation at any RF or modulation frequency. VSWR is less than 1.1 and frequency drift less than 0.001 percent over a ten minute period after warm-up. The 3-stage RF section is enclosed in a thick-walled aluminum casting, minimizing RF leakage and vibration-caused FM, and assuring mechanical stability. Both high voltage and heater supply are regulated. Output level is continuously variable from 0.1 to 100,000 microvolts. The carrier may be internally or externally sine wave modulated or externally pulse modulated. In pulse modulation, the rise time is better than 1 micro second from 6 mc to 120 mc and better than 0.05 micro second from 120 mc to 410 mc. Frequency calibration is within 0.5 percent and resettability better than 0.05 percent. Modulated spectrum distortion is less than 3 percent at 50 percent modulation. The instrument is small and compact for a generator of its capabilities.

★ ★ ★

P-5-4—Easy, accurate, non-destructive testing of precision ball and roller bearings is now made possible by the Model BA-22 Electronic Bearing Tester. The new instrument detects and pinpoints hidden faults one-millionth of an inch in size, without bearing disassembly. Bearings may be tested with or without grease, oil, or seals, and new bearings need not be cleaned before testing. An oscilloscope display combined with audible signal and simple dial settings make possible reliable operation of the instrument by untrained personnel. Radial or thrust-type bearings may be tested under load conditions in either the vertical or horizontal plane. Ball and roller bearings up to 14 inches in diameter are checked with extreme accuracy.

★ ★ ★

P-5-5—A simple test set for Type 6700 and Type BD-301 Beam Switching Tubes is now available. This Beam Switching Tube tester will enable the user to readily determine that the Beam Switching Tubes he is working with will meet commercial electrical specifications. The Beam Switching Tube tester is designed for extremely simple operation wherein all ten positions of the tube can be quickly checked both statically and dynamically. The tube tester Model No. 600 has the following features: internal power supply, regulated voltages, spade voltage meter, variable spade voltage control, target current meter, visual indication of beam position, manual or automatic cycling, beam form switch, beam clear switch, provision for monitoring cathode current externally, provision for monitoring and adjusting grid bias level, and built-in pin straightener. The unit comes in a case for bench operation from a standard 110 V AC supply. The price is $175.00.

★ ★ ★

P-5-6—Conventional methods for preparation of metallographic specimens sometime fail to produce satis-

New C-800 easier to read, easier to use

Chrome Clad. Easy to read because jet black numbers stand out sharply against soft, nonglare chrome.

Wide-Open, Double-Length Vernier. Reading is unobstructed with wide-open vernier. Graduations are twice as far apart as on standard vernier scales.

Bar at Front. Bar is at front of base, gets closer to work. Permits the machinist to read directly to zero.

Three-Point, Adjustable Gib. Gives uniform sliding action . . . holds jaw rigidly parallel to base at any position on bar.

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American Standard Inch-Millimeter Conversion Factor to Become Legal

The U.S., British and Canadian governments are planning to make 25.4 mm to 1 inch the legal inch-millimeter conversion factor. This is in accord with American Standard B48.1—Inch-Millimeter Conversion for Industrial Use. At present this factor is legal only in Canada. In the U.S. the legal factor is 25.400051:1 and in England, 25.399956:1. The American Standard factor of 25.4:1 was established in 1933 and reaffirmed in 1947. Even though the differences are in the range of only two millionths of an inch, they are significant in ultra-precision tooling and gaging where optical or electronic measurements are used.

factory results. As in the case of softer metals, for instance, the grinding process tends to smear or blur the surface. With certain alloys having constituents of different degrees of hardness, it is often impossible to obtain a completely flawless surface as the grinding process affects the softer constituents more than the harder particles. For many years, the feasibility of using microtomes to prepare metallic surfaces for microscopic examination has been explored. Entirely new knives and a special microtome for the preparation of metallographic specimens have been developed in Germany. The new JUNG Model "KM" is electrically operated and of extremely sturdy construction. The specimen may be mounted in resin or placed unmounted into the vice-type object holder and planed until a relatively smooth surface is achieved. The planing is done in steps of 10, 20 or 30 microns, depending on the size and hardness of the specimen. For final preparation of the surface the micrometer is adjusted to advance in steps of only 2 to 4 microns. Five to ten strokes are generally sufficient to complete the surfacing. The magnified observation of the surfaced specimen will now disclose fine parallel-running lines. As the identity of these lines is unmistakable, the sample can in many cases immediately be etched and examined. In most cases, electrolytic lap-polishing is recommended, as this process will eliminate the knife tracks completely. Fine polishing of the specimen can be accomplished by other standard procedures also. The speed of the cutting action of the microtome can be varied by means of stepless control. To avoid contact of knife and specimen on the return stroke, the object is lowered automatically prior to the next advance. The operation of the instrument assures completely uniform knife action and prevents undesirable distortions. Including preliminary handling and the mounting of the specimen, 4 to 6 minutes generally suffice for the preparation of a sample. The final surfacing takes only a few seconds. The Model "KM" microtome also finds valuable applications in checking films and coatings of materials, including oxides, and is also very useful in locating defects, as the instrument permits the removal of specific layers enabling the reconstruction of the material. The removed shavings are suitable for various analytical investigations as they are uniform in thickness.

★ ★ ★

P-5-7—A new electronic surface thermometer indicates accurate temperature measurements down to minus 328 degrees F. Companion to other "Thermophil" electronic thermometers which indicate up to 845 degrees F., the thermometer offers response times of less than one second in liquids and 2.2 seconds on surfaces. Full reading responses are 5 and 15 seconds respectively. Accurate temperature readings are obtained by the use of a stable thermistor resistance element, bridge circuit, amplifier and indicating instruments. Standard accuracies are up to ± 0.14 degrees C or ± 0.25 degrees F. Each instrument type has three or four overlapping scales, depending upon the model. Various instruments cover temperatures from minus 328 to plus 845 degrees F. or minus 200 to plus 450 degrees C. Readability is ¼ degree or better on standard models. The portable instrument measures only 7 inches by 5 inches by 2¼ inches, and can be carried on a strap like a camera. It is operated by standard batteries. Other units can be furnished for use on standard AC voltage lines for portable or panel mounted installations. Over 100 different, interchangeable probe designs and 26 instruments are available in the Thermophile line: with handles or for fixed installations, in lengths up to 63 inches or more with extensions, with thermistors mounted in glass or stainless steel, and with probe tips bent, forked (for readings on threads, wires and other strands), etc. Multi-probe switch boxes, panel mounted systems, alarms, controllers and recorders are furnished when required.

★ ★ ★

P-6-1—Reasoning that an ounce of prevention is worth much more than a pound of cure, Jones & Lamson Machine Co. has brought out a new service and maintenance policy for owners of its Optical Comparators. The "Certified Maintenance" inspectors from J & L will check all adjustments on all of the customer owned comparators covered in the agreement and maintain the accuracy of adjustments and operation of each one. A desirable feature of the certified maintenance contract is the written, dated certificate of precision for each comparator given to the owner of the comparator after each of the four per year inspections by J & L trained specialists. This will fulfill completely all government specifications for written certification on "gages" used on government contract work. Special bulk prices are offered for this service, or a single machine can be so covered.

★ ★ ★

P-6-2—Special attachments for knit goods evaluation together with a completely new tensile tester, have been introduced by Scott Testers, Inc. The new CRE Tester incorporates a special extended three inch thrust Ball Burst attachment for ASTM recognized tests of high-elongation constructions. In addition, the new CRE Constant-Rate Of Extension Tensile Tester will utilize a wide range of other Scott holding fixtures, evaluating fabrics, yarns and constructions by ultra-precise electric weighing, up to 1000 lbs. tensile. Simplified operation with single master control lever is a feature available only in this type of tester.

★ ★ ★

P-6-3—Eastern Precision Tool & Gage Co. announces their new Drying Recorder device by which precise measurement of drying time of any paint, varnish, lacquer, enamel or other chemical products is possible. This instrument is portable and compact enough to be used with auxiliary equipment to vary the atmospheric conditions under which drying takes place. To measure the drying time, films of the materials to be tested are applied with a specially designed film coating gage to one or up to six of the metal specimen strips available which are then placed on top of the recorder. On each of the strips coated, a hemispheric

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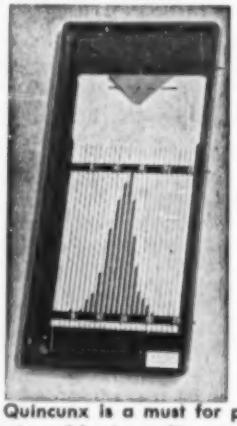

The Quincunx is a must for presentation of basic quality control principles. Demonstrates visually to your audience how a Normal Distribution pattern is formed. Also demonstrates how various Non-Normal distributions are formed.

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needle is brought to bear by means of a movable carriage to which a time indicator is attached. After the indicator is brought to zero on the time scale, a 110 v. synchronous motor draws the carriage along the length of the strips, making tracks in the film being evaluated. Through the use of a three speed gearbox, the total travel of the needles can be set to occur in 8, 16, or 24 hours so that the drying time of the quick and slow drying materials alike can be more accurately determined. The recorder registers different stages of the drying process and provides data on other physical properties of the film, that is, adhesion through drying, and tendency to wrinkle. The strips are easily removed to constitute permanent records and additional strips are easily obtained.

★ ★ ★

P-6-4—Apco Mossberg Co. has announced a new precision torque screwdriver for delicate assembly work. The "Tiny Torque" screwdriver enables anyone to tighten tiny screws without buckling delicate movement plates, shearing threads or cramping pin gears. The Tiny Torque screwdriver measures from 0 to 3 tenths of an inch-ounce torque or can be made to read from 0 to 6, 8 or 10 tenths of an inch-ounce torque. It is designed for #0 to 2-56 screws, but can be made to fit screw sizes ranging from #0 to 4, by changing the hardened screwdriver blade. The unit is designed for the ins'rumentation field, for delicate and precision assembly operations, watch and chronometer manufacturers and repairmen, electronics assembly and wherever the correct torque makes the difference between a successfully operating unit and a scrap reject. The screwdriver measures 4¾ inches long, including its steel driving tip. It has a polished fingertip rest and clear, easy-to-read white graduations etched on the blackened barrel. A mechanical stop prevents damage from over-torquing, and the barrel is knurled for easy handling. The Tiny Torque Screwdriver is precisely calibrated by gram weights.

★ ★ ★

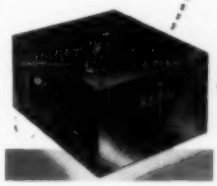
P-6-5—A new, versatile, automatic strain indicator, the Model LC-261 features the resolution (0.005 percent), linearity (0.02 percent), repeatability (0.01 percent) and accuracy (0.05 percent) required of a precision standard for calibration and linearity testing of high quality strain gage transducers. High accuracy and stability are achieved through use of the voltage ratio null balance principle in conjunction with a combination of tracking power supplies. Accuracies are not affected by variation of input and output impedance over the range of 60-1000 ohms. Designed for production line quality control, incoming acceptance testing and laboratory testing of strain gage transducers, the LC-261 is a true millivolt per volt indicator. The instrument can also be used as a high accuracy readout with any strain gage transducer whose millivolt per volt calibration is known. In-

The NEW Series BH100

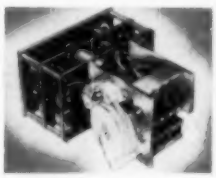
MILLI-V-METER*

DIGITAL READOUT

0001



SMALL SIZE — This compact, transistorized, servo-driven instrument measures only 3 x 5 x 5¾".



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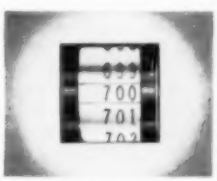

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- Critically damped response
- Simplified control panel
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The HR-92 is a null-seeking servo-type plotter designed to draw curves in Cartesian coordinates on regular 8½ x 11 graph paper. It employs conventional chopper amplifiers, 2-phase motors and a potentiometer rebalance. Reference voltages are furnished by mercury cells. Control panel has zero set and continuously-variable attenuator for each axis. Separate standby and power switches are provided. Two axes are electrically and mechanically independent. By moving an internal jumper lead, a high impedance potentiometer input can be made available.

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★ ★ ★

P-6-6—By the addition of gage wires to its expanding plug for cylindrical holes, Comtorplug now provides a gage for directly checking the "between pins" dimension of splines and internal gears. The gage may be designed for either odd-tooth or even-tooth work. The gage dial provides a reading of the dimension in 0.0001 inch graduations. Gages of this design are applicable to work having between-pins dimensions from approximately ⅜ inch to 10 inches. Zero setting is done in a plain ring gage. Due to the fact that each Comtor Spline Gage will be designed for the user's specific application, a print of the proposed application should accompany request for further information.

★ ★ ★

P-6-7—Metallurgical laboratories and steel mills will be interested in the new Cut Off and Upset Testing Machine for rods and bars, designed and produced by H. K. Porter, Inc. This device quality control tests the ability of bars to be upset as much as 50 percent in length. It cuts sample slugs to length in one station, after which the slug is placed under the upset head, which easily reduces the length up to one-half original size. In addition to its use in metallurgical laboratories and steel mills, the Porter Cut Off and Upset Testing Machine may be employed effectively in cold heading operations for testing coils before they are delivered to the machine. One of its great advantages lies in its portability, making it available for use in any convenient location within the conveyor systems as required. In the models handling rod up to ¾ inches in diameter, the machine, equipped with rubber-tired wheels, may be moved about easily, and connected to convenient outlets with a four-conductor extension cord. Porter Cut Off and Upset Testing Machines can be designed to handle all sizes of rod up to 1¼ inches in diameter, and the machines may be changed quickly to handle different rod sizes.

★ ★ ★

P-6-8—A new type of electronic-optical instrument, developed by Mark N Laboratory, measures thickness of sheet, foil or webbing of any width and material using a principle similar to the sighting of distant landmarks on the cross-hairs of surveying telescopes. The new gage does this automatically and requires no visual observation. Its optics are self-contained in a rugged housing from which electronic connections are brought out. Because of the principle used, the new gage is not a comparator and requires no standards of calibration. It has a motor-driven adjustment with a 5-digit dial on which appears the nominal thickness to which the instrument is set for a particular run, and which the material is supposed to approximate. This operation is very simple and can be done by untrained operators. Then as the material flows under the gage, a meter reads variations from the nominal thickness. The meter scale is available in several grades of accuracy and sensitivity depending on the tolerances involved. Normally, each scale division corresponds to 1/10,000 inch. Physical properties of the material are not involved in the measurement and opacity does not influence the measurement. For these reasons, the instrument is particularly suitable for quality control of materials such as paper, coated fabrics or plastics which do not lend themselves easily to indirect methods due to variations in their electrical or absorption characteristics.

★ ★ ★

P-6-9—An entirely new electronic instrument which automatically prints the weight of samples in an analytical balance has been announced by Wm. Ainsworth & Sons, Inc. The unit consists of an Ainsworth Right-A-Weigh analytical balance, an electronic unit, and an 8-piece printing adding machine. It covers the range from 200.0000 grams to 000.00001 grams. By pushing a button, the operator obtains a permanent record of the weight printed on a tape. Previous weight, tare weight, corrections for zero or buoyancy, and other data, can be automatically added to, or subtracted from the weight. Serial or sample numbers can be printed on the tape. The printer will "read" the balance and add the weight to, or subtract it from, any figure already in the printer and automatically print the sum or difference as a subtotal or total. In addition to convenience and speed, the instrument eliminates the possibility of human errors in reading, adding and transcription. Also, the balance and adding machine may be used independently.

New Literature Available

Two publications by the office of the Assistant Secretary of Defense (Supply & Logistics) have been recently made available to quality control personnel in Government and industry. A new Inspection and Quality Control Handbook H106, "Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes" is available for purchase from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price is sixty cents. These sampling plans have been found useful in many DoD applications in procurement and maintenance quality control operations when lot accumulation is not feasible. The second document recently published by the OASD

(S&L) is "Mathematical and Statistical Principles Underlying Military Standard 414". MIL-STD-414, published on 11 June 1957, provided the detailed sampling procedures and tables for inspection by variables. This new technical report describes the mathematical and statistical bases underlying the sampling inspection procedures contained in MIL-STD-414. It also contains the specific methods used in computing the various tables and operating characteristic curves of the Standard. This publication is also available for purchase from the Superintendent of Documents for twenty-five cents.

• • •

L-4-5—Catalog 8008 describing Moore Pneumatic Comparator Gages is now available. This publication presents an entirely new line of air gages for dimensional measurement and a series of automation building-blocks for size-control systems. It covers newly-standardized purchasing data on pneumatic plugs, rings and gaging cartridges—including the Moore Hardcoat (anodized aluminum) Plug and the L-Matic (Low-force) cartridge.

• • •

L-4-6—A new four page Data Sheet E-53 (1A) describing the Leeds & Northrup 4735 Guarded Wheatstone Bridge is now available. The sheet provides complete specifications including a table listing maximum applied bridge voltages and describes the features of

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this instrument that are extremely useful in precision laboratory experiments, in routine resistance measurements or production checking of resistors. A schematic diagram of the 4735 is shown as well as interior views of the instrument. Instrument accessories are listed and ordering instructions are included.

• • •

L-4-7—A new two-page bulletin describing the features, applications, and specifications of the Gilmore Portable Digital Indicator and Force Calibrator, Model 170, is being offered by the manufacturer. The Model 170 serves as a calibration standard for weight, force and thrust measuring systems, or as a high accuracy portable field indicator.

★ ★ ★

L-5-1—Bausch & Lomb Optical Company has issued a new 24 page illustrated index of optical products which lists all of the current Bausch & Lomb catalogs. It is divided into consumer, opthalmic and scientific and technical products classifications, corresponding to the major product divisions of the Company. This permits catalogs of allied products to be grouped together for quick, easy reference. Each catalog entry includes a cover illustration and brief descriptive data. A factual account of the contents is included and each catalog number is specified.

• • •

L-5-2—Bulletin 359 from Wm. Ainsworth & Sons, Inc., describes a new automatic, recording analytical balance. This electronic instrument for thermogravimetric analysis records both weight and temperature against time. The new model has two pens, using different colors, and records both weight and temperature against time on the same chart.

• • •

L-5-3—A. S. T. M. Standard Viscosity Tubes are described in a new bulletin published by Gardner Laboratory Inc. These tubes meet the requirements of proposed tentative method of test for viscosity by the Bubble Time Method, A.S.T.M. Designation D1545-58T.

• • •

L-5-4—Phoenix Precision Instrument Company, Inc. announces the availability of a new 12 page Bulletin K-5000. This bulletin describes the new Phoenix Model K-5000 Automatic Recording Amino Acid Analyzer. Included are schematic diagrams of the flow system used, detailed description with photos and actual curves on separation of amino acids as recorded with the analyzer. Many other fundamental investigations and control applications are feasible.

• • •

L-5-5—Invo Spline, Inc. has just completed their new eight page catalog outlining the large stock of standard fine pitch master spur gears that are carried in stock for immediate delivery. Also included in the catalog are charts showing required A.G.M.A. tolerances and rolling pressure chart. Invo Spline tolerances are shown in comparison with A.G.M.A.

• • •

A recent survey of supervisors was conducted by Management Information, 30 North MacQuesten Parkway, Mount Vernon, N. Y. In the interest of contributing to a better understanding of supervisory problems, this survey is available to interested executives, without obligation.

• • •

L-6-3—A technical bulletin #607 covering its new low-cost, compact and versatile gear checker designed for roll checking the most widely used range of gear sizes is now available from Michigan Tool Co. Using master gears rotating on a spindle in a replaceable precision bushing, the checker will indicate rolling errors on a dial gage in increments of 0.0005 inches.

• • •

L-6-4—A comprehensive 20 page brochure titled "Selecting Instruments to Solve Your Analytical Problems" has been published by the Instrument Division of the Perkin-Elmer Corp. The brochure discusses the applications of instrumental analysis and its advantages. It specifically tells how and why infrared and ultraviolet spectrophotometers and gas chromatography instruments are used and the benefits obtained with them. Typical spectra and runs, and instrument schematics are used.

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ASQC Announces

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Stephen, Chester S., Tucson, Ariz.
Storer, Harley E., Coal City, Ill.
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In addition, a special program on current developments and applications in industrial reliability problems is scheduled from July 27 to Aug. 14.

Participants may enroll in only one of the three courses, but all may attend two special series, both running from Aug. 3-14. The *general lecture series* will present luncheon and dinner talks by prominent representatives from government, education and private industry. The *practical aid series* will consist of laboratory sessions, films and field trips.

Enrollment will be limited. Training directors and other interested persons may obtain information and applications from Prof. Edward P. Coleman, Dept. of Engineering, University of California, Los Angeles 24, Calif.

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PRICE, KENNETH O., Tulsa, Okla.
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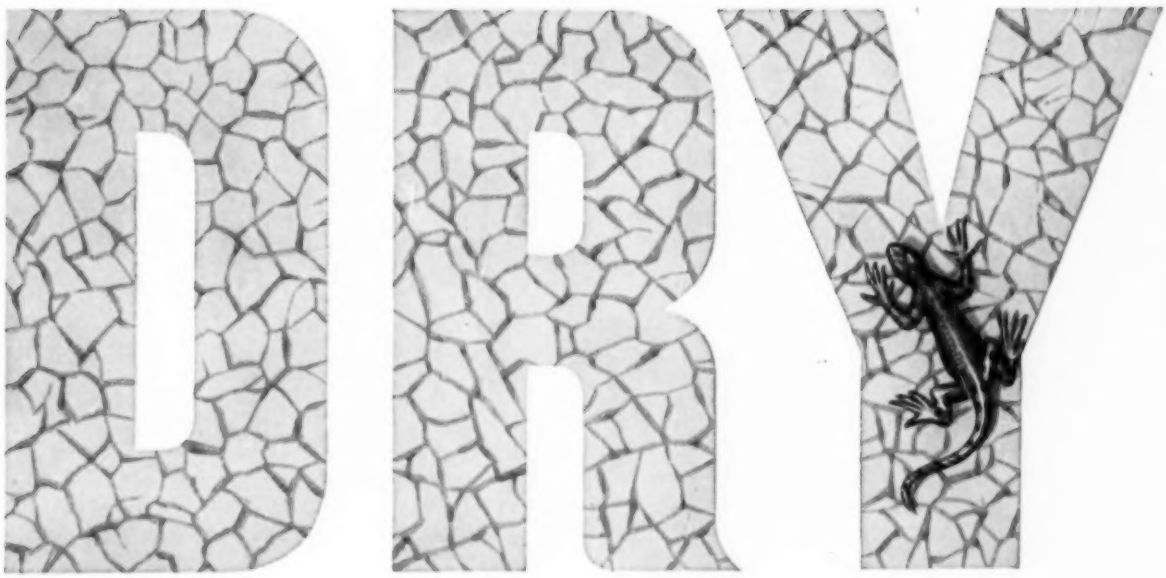

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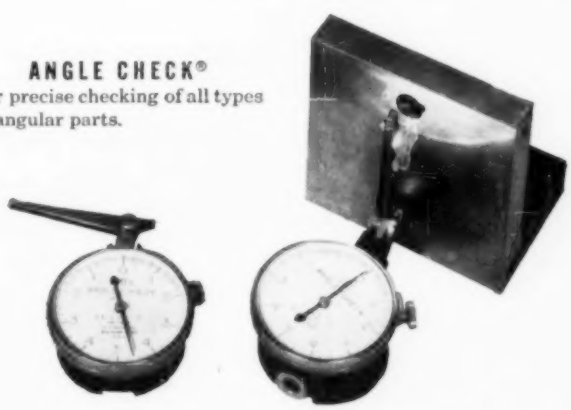
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